POWER PLANT ENGINEERING

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New Plant of the Continental Motors Corporation

COMBINING SOUND ENGINEERING FEATURES WITH SIMPLICITY OF DESIGN MAKES THIS PLANT THE LAST WORD IN MODERN POWER PLANT CONSTRUCTION

SITUATED AS IT IS, within a hundred feet from the water's edge on the shore of Muskegon Lake, it is at once obvious to even a casual observer that the new power plant of the Continental Motors Corporation at Muskegon, Michigan, will not suffer from a lack of clean, cool condensing water. Each of the 22,000 sq. mi. comprising the area of Lake Michigan into which Muskegon Lake empties backs up the guarantee of an adequate, uniform water supply with absolute certainty. Indeed the only possible difficulty which might have been encountered in connection with the condensing water supply was that due to ice in winter, but due to the foresight of the engineers responsible for the design of the plant, even this difficulty has been precluded by a suitable arrangement of discharge and intake tunnels.

Construction on this plant was started in August, 1919, and it was first put in service January, 1921. Although in operation at the present time, construction work is not entirely completed and the finishing touches are still being applied.

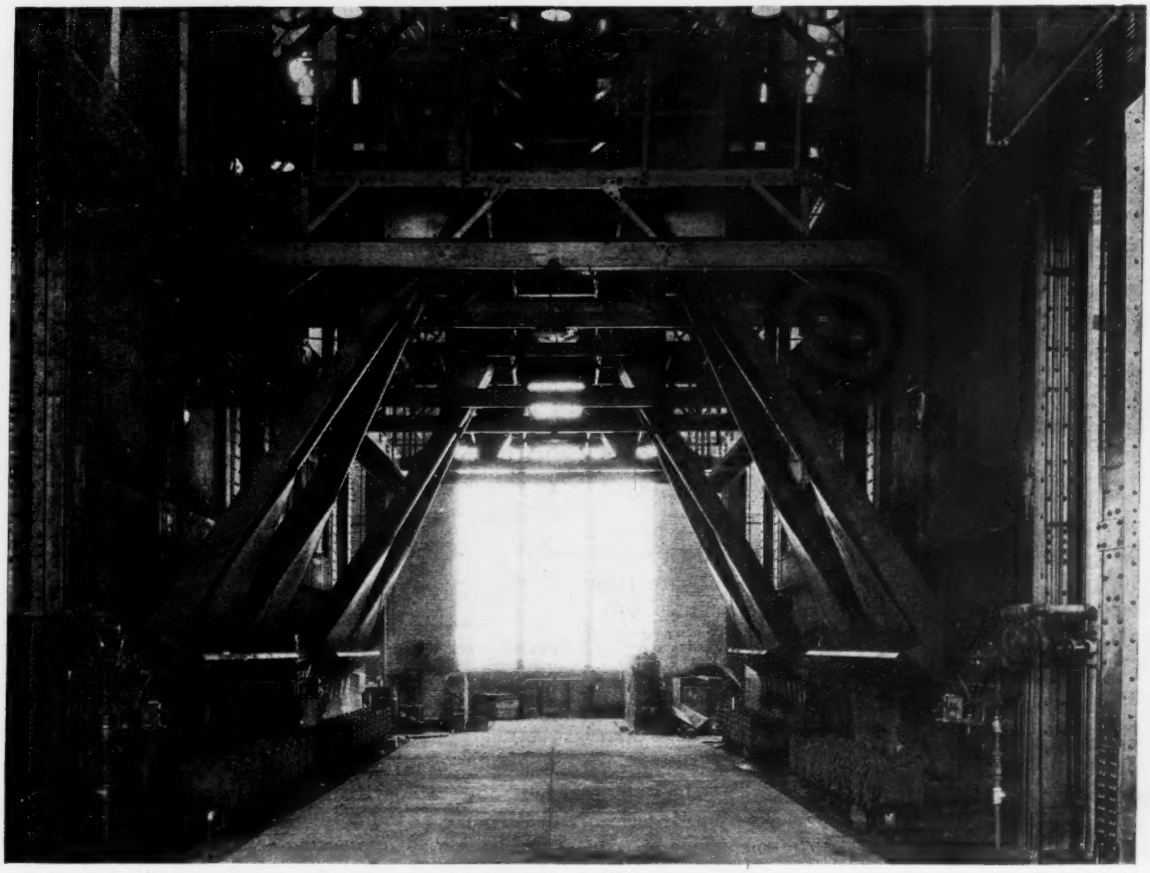


FIG. 1. INTERIOR VIEW OF BOILER ROOM

The factory which it serves is entirely devoted to the manufacture of gasoline engines for automobiles and tractors and together with the company's other factories is the largest exclusive motor manufactory in the world. About 4500 men are normally employed. The new power plant furnishes the factory with all necessary light, heat and power; no electrical energy whatever being purchased.

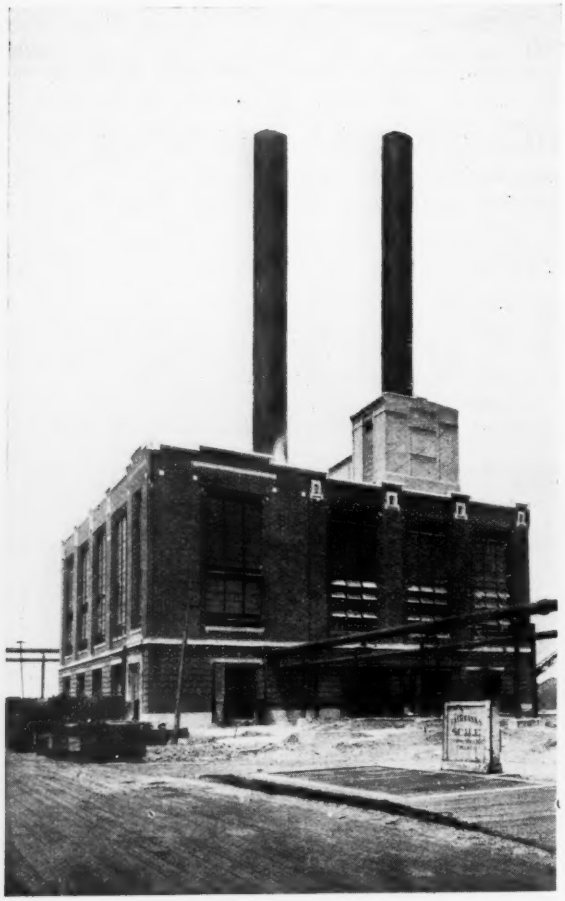


FIG. 2. THE NEW PLANT OF THE CONTINENTAL MOTORS CORPORATION AT MUSKEGON

There is installed at present boiler capacity totaling 3200 rated hp., while the initial generator capacity totals 6875 kv.a. The present buildings, however, are large enough to admit of double the present amount of boiler capacity being installed and space has been provided for an additional 5000-kv.a. future generating unit.

Coal Handling Equipment

Ample ground space has been provided around the plant to facilitate the storage of coal and the railroad has convenient access to the premises. Coal is stored outdoors on each side of railroad tracks by a large locomotive crane owned and operated by the company.

Coal for immediate operating purposes is delivered from bottom dump cars into a large track hopper located adjacent to the west wall of the building as shown in Fig. 6. From the track hopper, the fuel is fed to either or both of two Jeffrey apron conveyors set at an angle of about 35 deg. One of these conveyors delivers the coal to a Jeffrey crusher and then into the buckets of a Jeffrey vertical scraper conveyor while the other apron conveyor feeds directly into a separate scraper conveyor; that is, without first passing the coal through a crusher. There are thus, two apron conveyors, two vertical scraper conveyors or bucket elevators, and one crusher.

The object of having two systems is not, as may be supposed, to afford duplicate systems for insuring continuity of operation, but rather for convenience in handling two kinds of coal. Regular run of mine coal is always handled on the system equipped with the crusher, since this coal is unsuitable for burning in the sizes as ordinarily delivered to the plant. When fine screenings are obtainable, however, they are handled by the system not equipped with the crusher. This, it is evident, will effect an appreciable saving in operating costs if such coal is to be had. Whether this more or less elaborate system of coal handling is justifiable from the point of view of initial cost and interest charges on the investment is a point which future operating experience will have to decide. The two systems, as installed, are not interchangeable; that is, the conveyor normally used for fine screenings could not be used to elevate the crushed mine run in case the other system was disabled. The crusher may be bypassed, however, which allows screenings to be elevated on the run of mine bucket elevator should this become necessary due to a

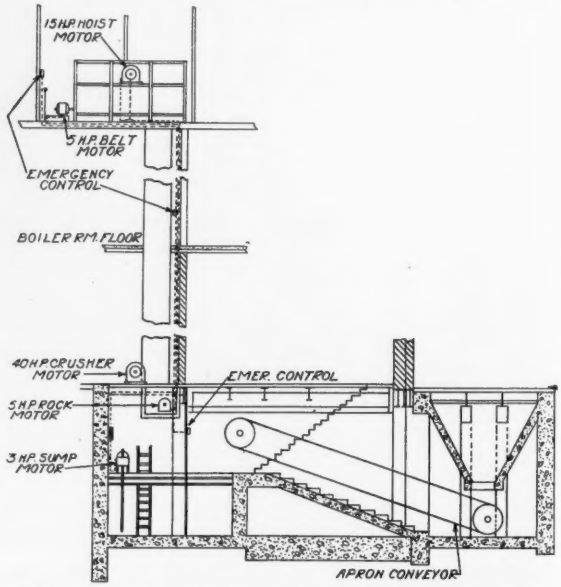


FIG. 3. SECTION THROUGH COAL CONVEYOR AND ELEVATOR

breakdown, It seems possible, however, that it would incur but little labor and expense in order to make both systems entirely interchangeable each way. Assuming that this is possible, then the expense of such an elaborate duplicate system of coal handling will be fully justified from the point of view of reliable operation.

The two apron conveyors are operated by individual electric motors; the one equipped with the crusher by a 440-v., 50-a., 60-cycle, three-phase induction motor while the other is run by a small 5-hp. induction motor. Both motors are controlled by automatic starting compensators located on the ground level or "blower" floor.

Coal is carried to the upper part of the boiler room by the bucket elevators where it is delivered to a Robins belt conveyor through a specially designed chute. Each elevator is operated by an electric motor, located at the upper end of its travel and controlled by starting compensators at that point.

The belt conveyor is of the multiple idler type and extends the entire length of the building above the coal bins. It also is operated by an electric motor of about 5 hp. capacity. A traveling tripper distributes the coal uniformly along the length of a Brown Hoisting Machinery Co. coal bin, which is of a parabolic type suspended from steel girders above.

Ashes

Ashes is delivered directly from the ash hoppers below the furnaces through hand operated ash gates into railroad cars which are run into the ash receiving room below the boiler room. The ash gates are of the sliding, horizontal type, operated through rack and pinions by hand wheels as shown in Fig. 6. The hand wheels are conveniently accessible from a suspended steel platform extending the entire length of the basement. As shown in Fig. 6, the ash handling arrangement is symmetrical for each side of the boiler room.

An ash spray, consisting of a pipe drilled with small holes, is located at the upper part of each ash hopper for the purpose of cooling the ashes and settling the dust.

This system of ash disposal is probably as simple and economical as any system in use and is at all times perfectly reliable and not subject to stoppage or breakage. It requires no power and unskilled labor is capable of doing the work.

The ash receiving rooms are light and roomy, being open at both ends for the entrance of railroad cars and also lighted by large windows.

The Boiler Room

The boiler room occupies an area approximately 124 ft. long by 84 ft. wide, and, measuring from the boiler room floor, is about 50 ft. high. There are two batteries of boilers, one line on each side of the room with the firing aisle between as shown in the cross section of the plant, Fig. 4. The overhead coal bins are suspended from above, and occupy the space above the firing aisle.

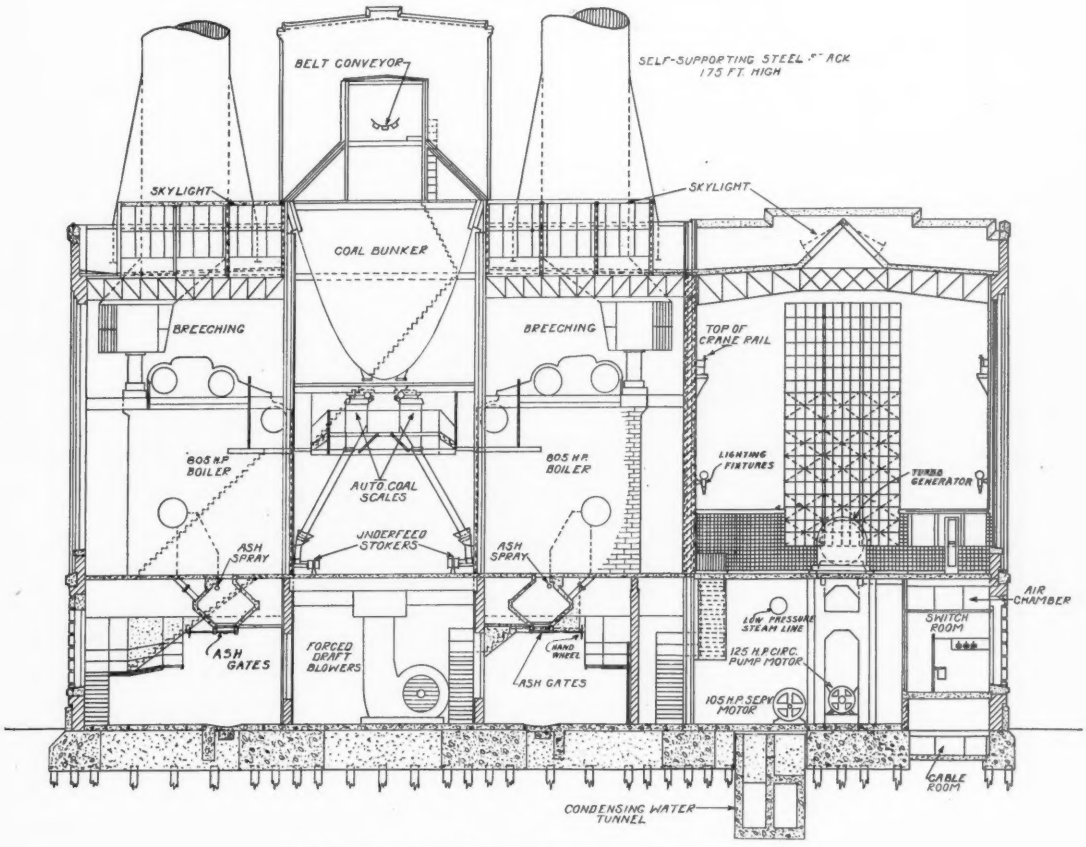


FIG. 4. TRANSVERSE SECTION THROUGH POWER PLANT

In addition to the large windows on three sides of the room which furnish natural illumination, a number of skylights directly above the boilers eliminate practically all necessity for artificial illumination during the day time.

Four 805-hp. (rated capacity) Connelly water-tube boilers equipped with superheaters, furnish steam at a normal pressure of 180 lb. at 100 deg. superheat.

These boilers are all equipped with Jones nine retort underfeed stokers of the automatic cleaning type and with Diamond automatic soot blowers. Steam to the

stoker retorts is controlled by Cole automatic regulators which are in turn driven from line shafting connected to the blower turbines in the basement. The stokers and the automatic regulators are clearly shown in the photograph, Fig. 1.

Forced draft is furnished by two large Green Fuel Economizer Co. blowers located in the basement underneath the firing aisle, as shown in Fig. 7, each driven by an 80-hp. Terry steam turbine through reduction gearing. As the speed of the blowers is automatically regulated by the steam pressure, the stoker regulators, being driven by the blower turbines will, as a consequence, regulate the stokers according to the steam pressure.

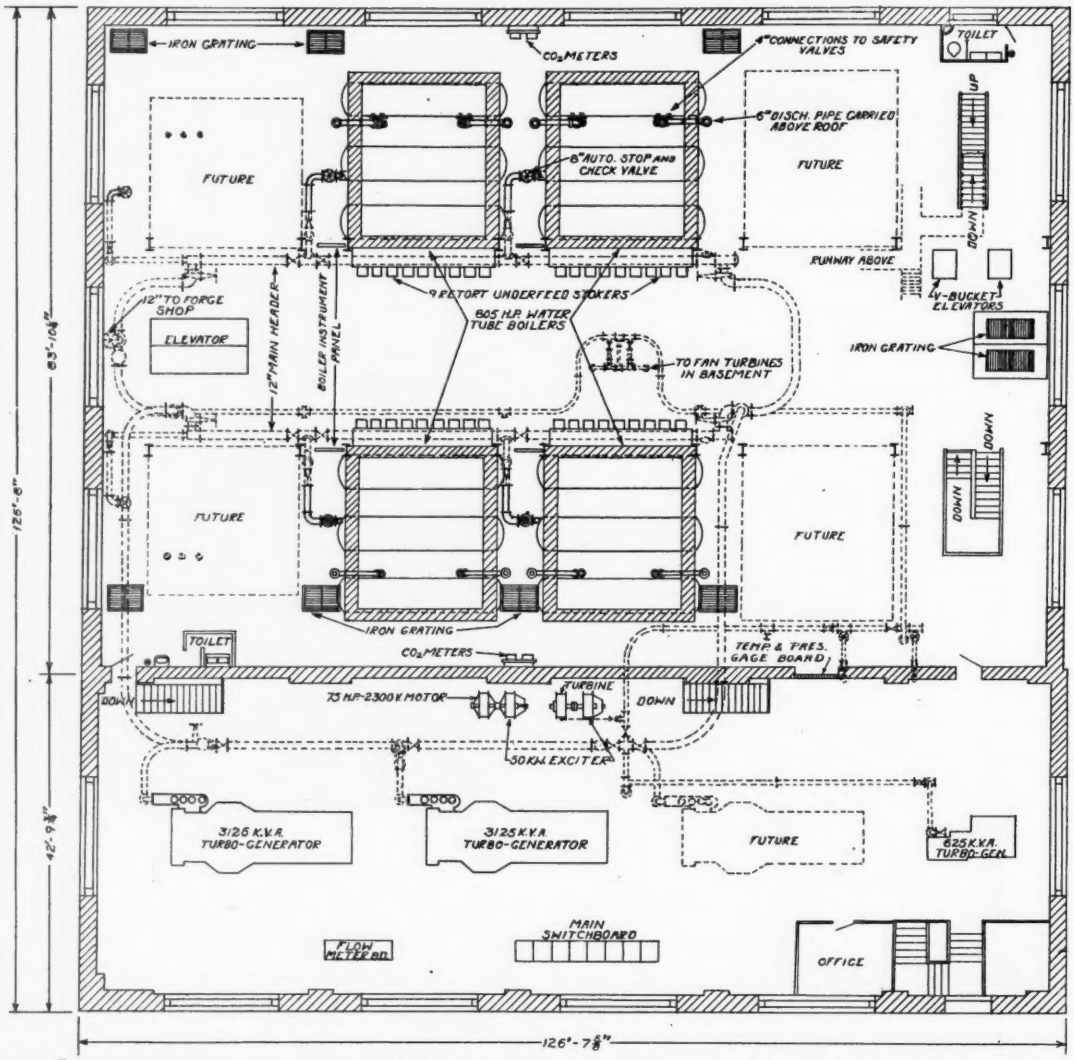


FIG. 5. PLAN, TURBINE AND BOILER ROOM LEVEL, SHOWING HIGH PRESSURE STEAM PIPING BELOW FLOOR

Automatic Scales

Coal is delivered to the stoker hoppers from the overhead coal bin through Reliance automatic coal scales. There are four of these scales, one for each boiler; each one located directly beneath a valve in the coal bin and opposite the boilers. These scales, shown in the upper part of Fig. 1, operate in the following manner:

Coal from the overhead bin is fed upon a flat circular plate, placed in a horizontal position so that the coal forms a conical pile. Just above this disc there is a stationary casting which serves to scrape or plow off a certain amount of coal as the disc is driven on its axis by an electric motor. The coal thus scraped from the disc falls into a cast-iron hopper having vertical sides and rounded corners which hold the unit weighment. As the amount to be weighed is approximated, the scale beam begins to tip down. The first part of this motion throws out the clutch driving the feed disc, and stops the discharge of coal into the hopper. A sliding weight serves to compensate for the amount of coal momentarily in suspension and makes the net weight of coal actually delivered to the hopper the net weight desired. The second part of the downward travel of the weigh hopper trips the balance gate serving as a hopper bottom and the entire amount of coal is instantly dumped out through the coal spouts feeding the stoker hoppers below.

If the clearance is sufficient, when the last piece of coal clears the hopper bottom, the weigh hopper starts

to return to its original position. The slightly overbalanced bottom first closes and then the driving clutch is thrown in and the feed is resumed.

The capacity of the weigh hopper being known, it is merely necessary to record by means of an ordinary counter, the number of times per day that the operation takes place in order to determine the amount of coal consumed.

These scales are readily accessible for inspection or repair by a well designed system of suspended steel gratings and stairways, all equipped with hand rails.

While this system of feeding coal to the stokers is probably a bit more elaborate than found in most plants, it requires no care except perhaps a daily inspection, and is entirely automatic in operation.

Instruments

At the side of each boiler facing the firing aisle is mounted a marble panel equipped with a well selected group of instruments, enumerated as follows: one Republic indicating steam flow meter, one Republic integrating steam flow meter, one Republic recording steam flow meter, one Foxboro recording thermometer (stack temperature), one Foxboro recording draft gage.

These instruments, for each boiler, give the firemen all the necessary information for the intelligent and correct operation of the boilers, and at the same time furnish a permanent record of operating conditions for the chief engineer.

Foxboro CO_2 recorders, one for each boiler, are mounted on panels on the wall behind the boilers as shown in Fig. 5.

The firemen check the evaporation every hour while the chief engineer calculates the total evaporation every 24 hr. and checks his figures with the combined firemen's reports. An analysis of the coal is made weekly by the chief engineer.

Two self supporting steel stacks 178 ft. above the base line or 225 ft. above the boiler room floor serve to produce the necessary draft above the grates and remove the products of combustion. One stack serves a line of boilers on each side of the boiler room.

The Turbine Room

When the engineers responsible for the design of this plant planned the turbine room, they considered it not alone from an engineering standpoint, but from an artistic standpoint as well. With walls faced with a cream colored pressed brick, a light green tile wainscoting extending about 8 ft. from the floor and separated from the brick by a dark blue tile border, the room presents a pleasing appearance. A floor of grey tile blocks harmonizes well with the tile wainscoting. Considerable time and expense was incurred in selecting suitable combinations of tile for this wainscoting and floor, but the final result seems to have fully justified the efforts expended towards that end.

Large windows furnish an abundance of natural illumination and at night the room is lighted by artistically designed wall lighting units. These are spaced about 20 ft. apart at a height of 12 ft. from the floor and may be seen in the photograph, Fig. 10.

Present generating equipment consists of two 3125-kv.a. 2400-v., three-phase, 60-cycle, 3600-r.p.m. Westing-

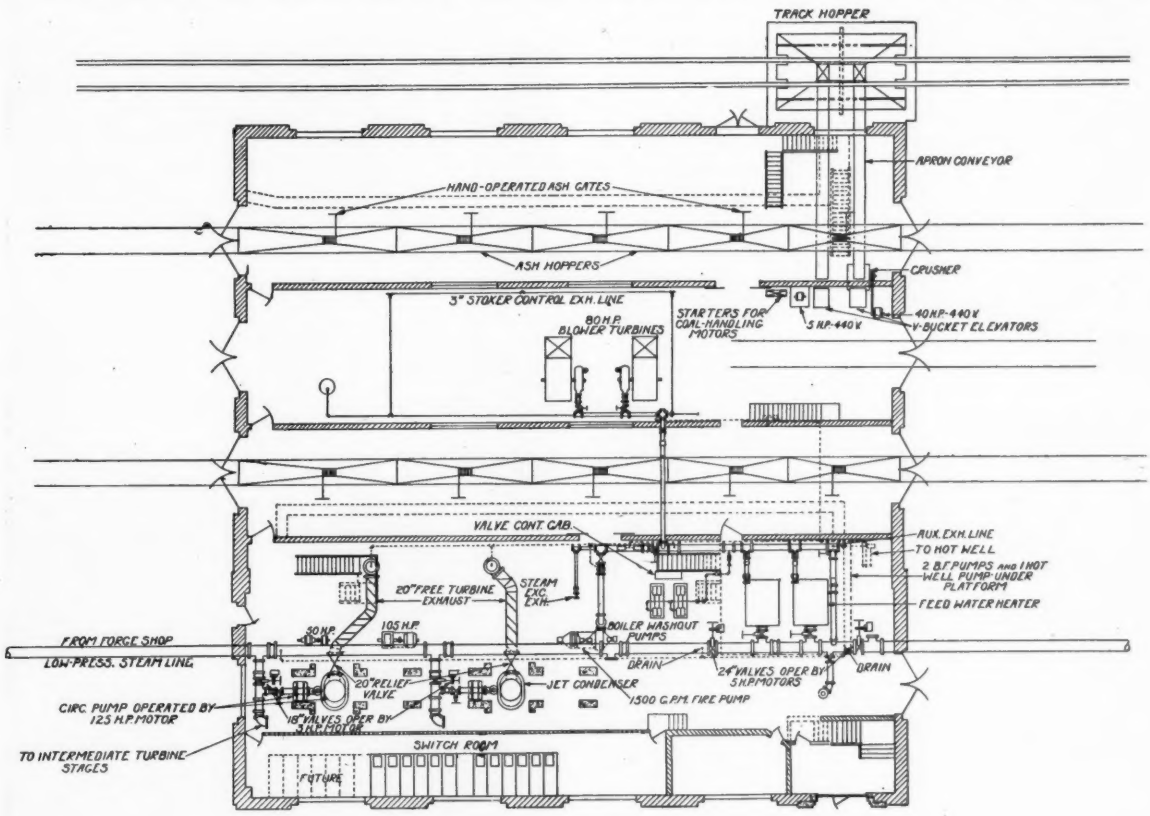
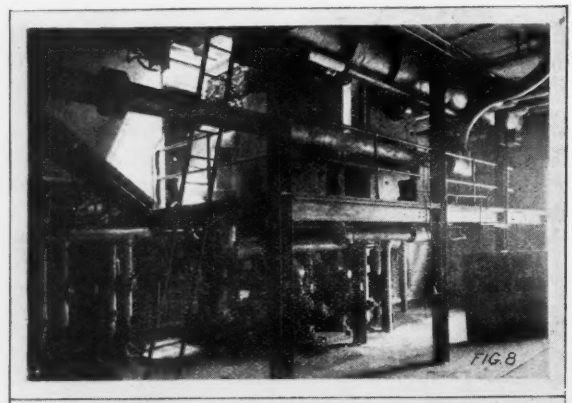
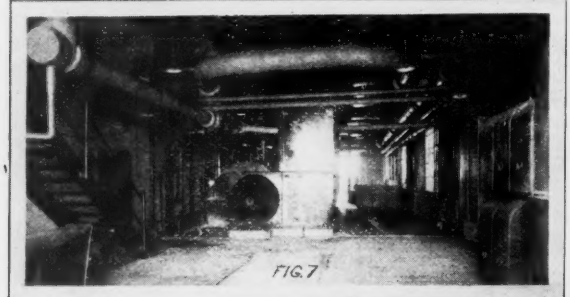


FIG. 6. PLAN, GROUND FLOOR. SHOWING LOW PRESSURE STEAM LINES

house turbo-generators, and one 625-kv.a., 2400-v., 900-r.p.m. turbo-generator together with separate exciting units and control equipment.

All generators are excited from a common exciter bus fed by either or both of two 50-kw., 125-v., 400-amp. exciters, one set being motor driven while the other is driven by a 75-hp. steam turbine. The 625-kv.a. turbo





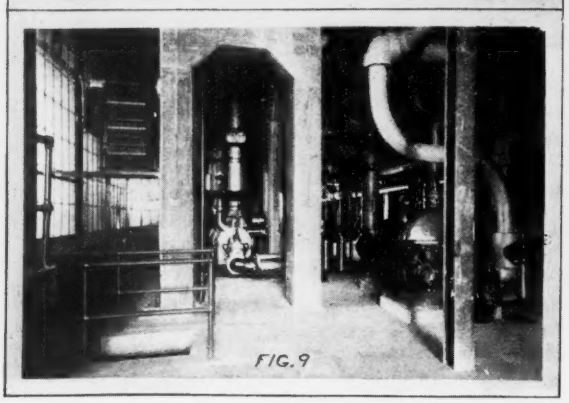


FIG. 7. BLOWER ROOM, BELOW BOILER ROOM
FIG. 8. FEED HEATERS ON PLATFORM, WITH CENTRIFUGAL BOILER FEED PUMPS BELOW. BOILER WASHOUT PUMP AT THE EXTREME LEFT
FIG. 9. VIEW IN THE PUMP ROOM. JET CONDENSER CAN BE SEEN BETWEEN TURBINE FOUNDATION SUPPORTS

is also equipped with a 6-kw., 125-v. direct-connected exciter which is used in case of emergency.

Mixed Pressure Turbines

The two large units are mixed pressure turbines, and in summer when a large amount of exhaust steam from the forge shops in the factory is available, operate on both exhaust and high pressure steam. The exhaust steam is introduced into the lower stages of the turbine. In winter, however, when the demand for exhaust steam for heating exceeds the supply from the forge shop, steam may be bled from the low pressure stages of the main turbines to make up the amount required for heating. As shown in Fig. 6, the low pressure main from the factory runs clear through the power plant and steam may flow in either direction.

These two units exhaust into a Westinghouse Leblanc jet condenser capable of maintaining 28 in. of vacuum in the basement. Each condenser is fitted with a condensing pump connected to a 125-hp. non-condensing turbine.

Condensing water, as stated at the beginning of this article, is taken directly from the lake through stationary water screens. Normally the condenser discharge is some distance from the condensing water intake, but provision has been made so that in winter when the intake may be obstructed by floating ice, the discharge will be directly below the intake. The warm water issuing from the discharge will thus prevent any serious difficulties due to ice from arising, and will also prevent excessively cold water from being taken into the condenser.

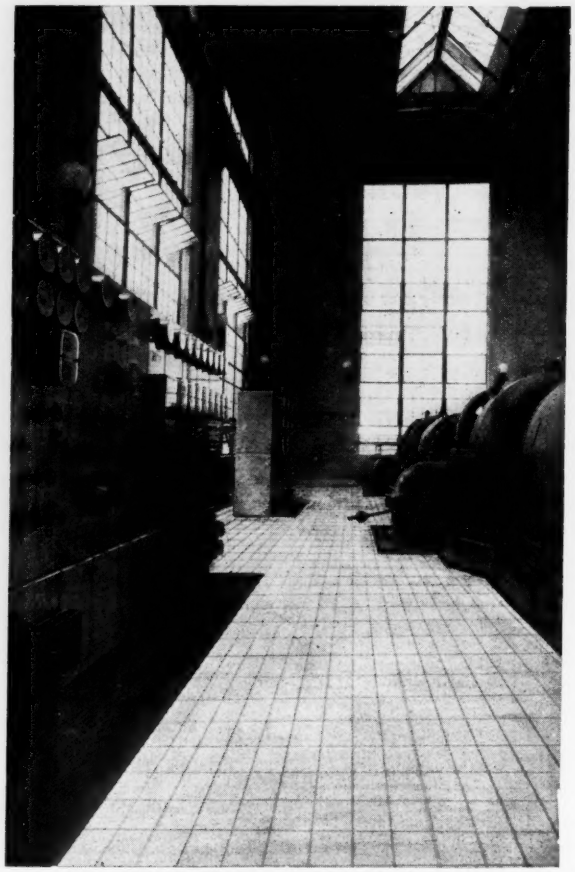


FIG. 10. PHOTOGRAPH IN THE TURBINE ROOM, SHOWING MAIN SWITCHBOARD AND PART OF THE TWO MIXED PRESSURE TURBO-ALTERNATORS

The small 625-kv.a. unit referred to above is used to carry the load during noon hour or at night when the load drops below 200 kw. This machine operates non-condensing and exhausts into the low pressure exhaust mains at all times.

Auxiliaries

All piping and auxiliaries with the exception of the exciters are located in the basement or ground floor, as it is called.

The two Cochrane feed-water heaters, each with a capacity of 21,000 gal. per hr., fitted with recorders for V-notch flow meters are mounted on a platform between the ground floor and the turbine room floor. This location simplifies piping and renders them convenient of access. Both the main and auxiliary exhaust mains connect into the heaters as shown in Fig. 6.

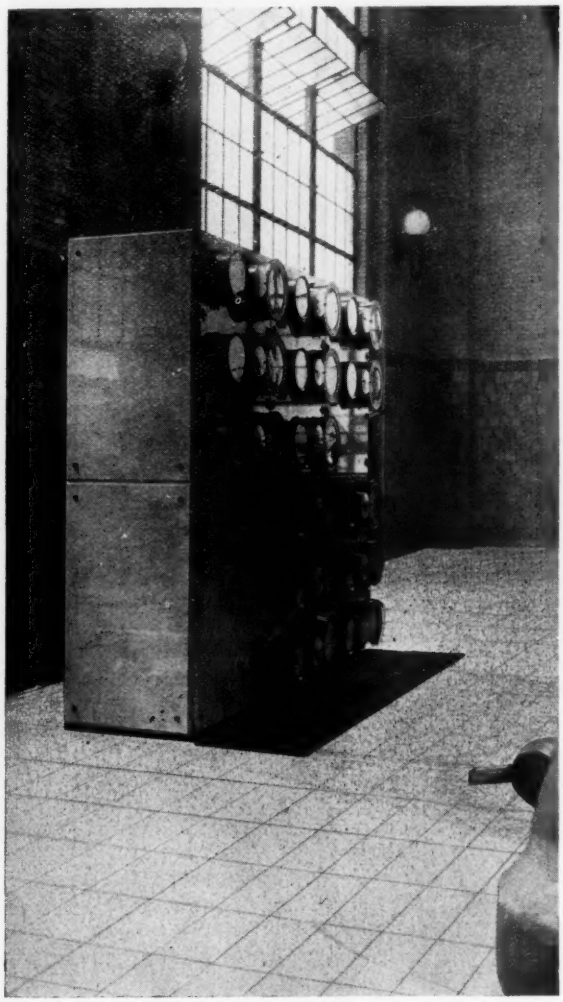


FIG. 11. THE STEAM FLOW METER PANEL

Two Manistee centrifugal boiler feed pumps driven by Westinghouse steam turbines are located underneath the feed-water heater platform and a small vertical motor driven pump placed next to them is provided for pumping water from the hotwell up into the feed-water heater.

For boiler washout purposes, two Burnham steam driven, duplex pumps are provided. These are located adjacent to the feed pumps.

A 1500-g.p.m. centrifugal fire pump driven by a steam turbine and two motor driven centrifugal pumps complete the pump equipment. The latter are service pumps for factory and power plant service, one of which has a capacity of 850 g.p.m. while the other is rated at 1000 g.p.m.

It will be noticed by inspection of Fig. 6 that the two 24-in. gate valves in the main low pressure exhaust line on each side of the feed-water heaters and also the two 18-in. valves in the connection between the main exhaust line and the mixed pressure turbines are electrically operated. These four valves are equipped with the Dean system of electrical control which enables them to be operated from a number of different control stations at will. For the benefit of those readers not familiar with this method of valve control, the following brief description is given:

The system consists of a single unit in which is incorporated the driving motor, reduction gears and limit trip mechanism. This unit is rigidly bolted to the valve. The motor shaft is connected to the valve stem through a system of combination worm and planetary gearing for the necessary reduction in speed which is generally about 40 to 1.

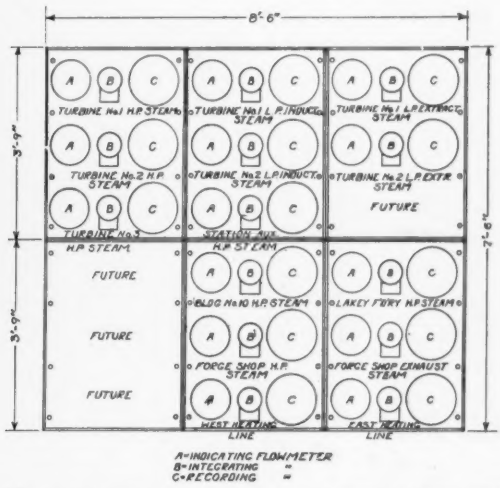


FIG. 12. ELEVATION OF STEAM FLOW METER PANEL SHOWN IN FIG. 11

The method of obtaining a quick stop and eliminating the effects of momentum and overtravel are obtained in the following manner:

Figure 13-A shows the assembly of the planetary gear, the external member or internal gear of which is marked I. The center or sun pinion is caused to revolve by the motor and this pinion turns the planetary pinions and shaft in the direction shown. The outer member or internal gear is free to revolve on a machined surface in the casing, but is restrained from doing so by two plugs which also pass through the casing as shown. Figure 13-B shows another view of the outside surface of the internal gear and it will be seen that this surface is provided with two peripheral channels, one extending half way around in one direction as shown at C—and the other in the opposite direction shown at D. When both plugs are in, or in the locked position the internal gear cannot move, therefore with the sun pinion being driven by the motor, the planetary pinions must turn on their own axes and travel around the internal gear.

Referring again to Fig. 13-A, we will assume that the valve is closing and the plug is restraining the movement of the internal gear which tends to move in

the direction indicated by the arrow E. At a predetermined moment when the valve is tightly closed, but not jammed, this plug is quickly withdrawn from the slot by a special cam movement, and since there is no friction now restraining the movement of the internal gear it is, of course, free to revolve in the direction shown. At the precise moment of withdrawing the plug the electrical circuit is interrupted by the limit switch and the drift of the motor coming to rest is taken by the internal gear revolving in its casing.

During the opening of the valve the motor will of course be reversed and it will be noted that the internal gear will have to make half a revolution in the opposite direction before the plug comes in contact with the stop, thereby allowing half a revolution of the internal gear before the valve actually starts to operate. This provides the hammer blow which is sometimes necessary to open a tightly seated valve.

In the photograph, Fig. 11, is shown the steam flow meter board, an elevation of which is shown in Fig. 12. This board located in the turbine room in line with the main switchboard, as will be seen, contains indicating,

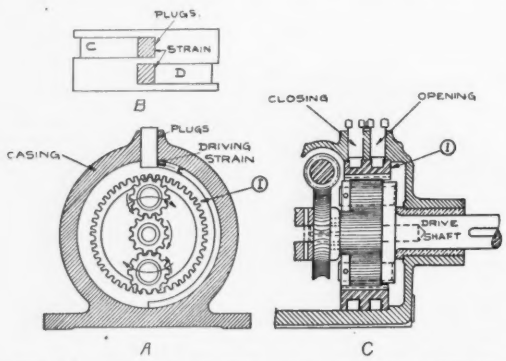


FIG. 13. DETAILS OF THE DEAN CONTROL SYSTEM

integrating and recording steam flow meters for each of the three conditions of steam used by each main turbine as well as for the steam delivered to various shops.

Another panel designated as "temperature and pressure gage board," at the other end of the room, contains the steam pressure and temperature and water pressure and temperature gages.

It is obvious, therefore, that there is no lack of instruments and meters in this plant and by their intelligent use, although the plant has been in operation only a short time, very satisfactory results have been obtained.

The feed water temperature carried is normally 212 deg., although by increasing the back pressure on the low pressure main it can easily be brought to 220 deg. This, however, while making a better showing for the power plant would be had at the expense of the forge shops since they would be forced to operate against a higher back pressure.

Electrical and Steam Distribution

The electrical distribution system is a 2300-v., 60-cycle system consisting of lead covered cables in vitrified tile, laid in concrete ducts. Approximately one mile of this duct is provided throughout the plant. This 2300-v. system supplies six banks of transformers stepping the voltage down to 440 for use in the shops. Approximately 7000 motor hp. forms the factory load.

An extensive overhead high and low pressure steam distribution system is provided. All steam lines are covered with 85 per cent magnesia insulation while the water lines are insulated with an air cell covering. A well planned scheme of pipe coloring is used for identifying pipe contents and size, the latter being determined by the width of the stripe.

The building is of brick and steel construction with concrete floors. The exterior is faced with red pressed brick and the large windows are equipped with steel sashes glazed with wire glass. Natural illumination abounds and it may be truly said that there is not a dark nook or corner in the entire building.

All engineering was done by the Arnold Co., of Chicago, to whom, together with L. J. Kanitz, of the building department of the Continental Motors Corporation, credit is hereby extended for much of the information and data used in the preparation of this article.

Flood Does No Harm to Pump Motors

RECENTLY a happening in a large New York bank showed the advantage of having the top heads of vertical motors enclosed. These motors, which were the driving end of a set of Yeomans Bros. duplex bilge pumps and sewage ejectors, were so located that there was only 6 ft. room for the set, whereas it was built for a pit 8 ft. deep. To facilitate handling the equipment, an opening 3 by 3 ft. was cut in the floor above, and to protect the motors and controls from dirt during this operation a thin muslin was thrown over them. Directly above the installation was a sprinkler head.

One night the masons failed to remove the cloth from the motors and it caught fire in some way, presumably from contact with the automatic-starter terminals, the heat opening the sprinkler head which discharged 5000 gal. of water on the motors and surrounding machinery. The motors, protected by the enclosing heads, suffered no damage, so far as could be ascertained, and the pumps were soon operating as usual.

And Occasional Discord, Eh?

He was one of the old school, but on the retired list. Hearing of the new up-to-date test room, he dropped in to see the latest and greatest, and the first thing that struck him forcibly was the youngsters running the place. The chief electrician asked the oldtimer what he thought of the layout.

"It's great, and it reminds me of music."

"How so?"

"Because there are so many meters and minors."

According to Industrial News Survey, U. S. Secretary of Commerce, Herbert Hoover, has made public a suggestion that all public utilities that have not purchased their bituminous coal for next winter do so at once. If this warning is neglected, he intimates, Interstate Commerce Commission may be little inclined to grant priority later on to the coal needs of such companies.

Governor Belt Accident

BEING AN ACCOUNT OF A PECULIAR ACCIDENT WHICH MIGHT HAVE BEEN AVERTED HAD PROPER INSPECTION BEEN MADE. BY GEORGE C. STIERHOFF

IT IS the small and detail parts of any machine which must have the most careful consideration. Large things are evident and can be seen at a glance, but the small things are important and must be investigated thoroughly. As we have often heard, "A chain is only as strong as the weakest link."

Here is a most peculiar accident which may be, or something similar, endangering your engine, and perhaps at the same time endangering your life. It was due to the failing of this governor to work as it had been designed to do. Had the engineer been careful and inspected the governor gear regularly, he would, perhaps, have eliminated the accident; or had he been well informed on the practicability of such mechanism, he would have noticed it as being a weak link, and could have remedied it quickly, with but little expense or trouble. Although of course it was a slip, originating with the designing engineer, and being constructed without anyone having noticed that it was weak.

The front and side elevations, Fig. 1, show the principle of the arrangement of this engine governor gear, and it is supposed to have worked as follows:

The pulley A is a small governor pulley driven by the governor belt from the main shaft, and through the governor shaft B transmit the motion to the governor C which is enclosed in a casing. The motion of the governor caused by the irregularity of the speed is transmitted through link D which is connected to and causes lever arm E to oscillate the inner shaft F upon which it is keyed. On the opposite end of shaft F is rigidly keyed the recessed lever arm G, which is kept parallel with lever arm H, by the flat fillister head bolt I. This bolt is held in place by the compression spring J. Lever arm H is keyed to the outer shaft K, and through it is transmitted the original regulating motion from the governor to the lever arm L which is also keyed to the hollow shaft K at the opposite end. The lever arm L is connected to lever arm M, which is keyed to shaft N, and at the opposite end of which is keyed lever arm O. This has connected to it links P_1 and P_2 which are the governor reach rods to cutoff. Resting on the governor belt is the idler pulley Q which runs on a short shaft connected to lever arm R. Lever arm R is connected by a bearing stud to the frame of the engine; also connected to lever arm R through shaft S is a slotted cam link T.

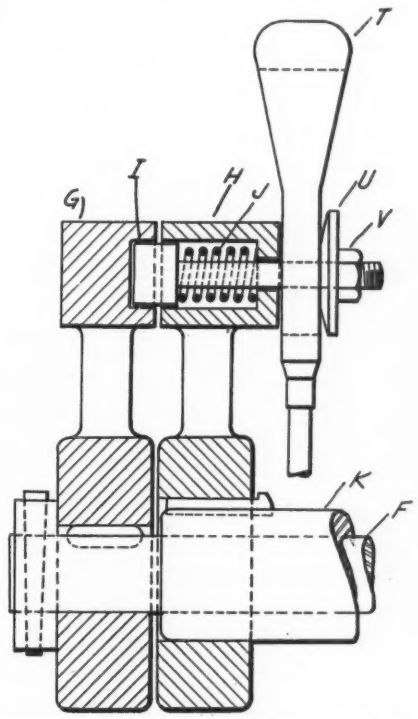


FIG. 2. ENLARGED SECTIONS OF GOVERNOR CAM IN NEUTRAL POSITION

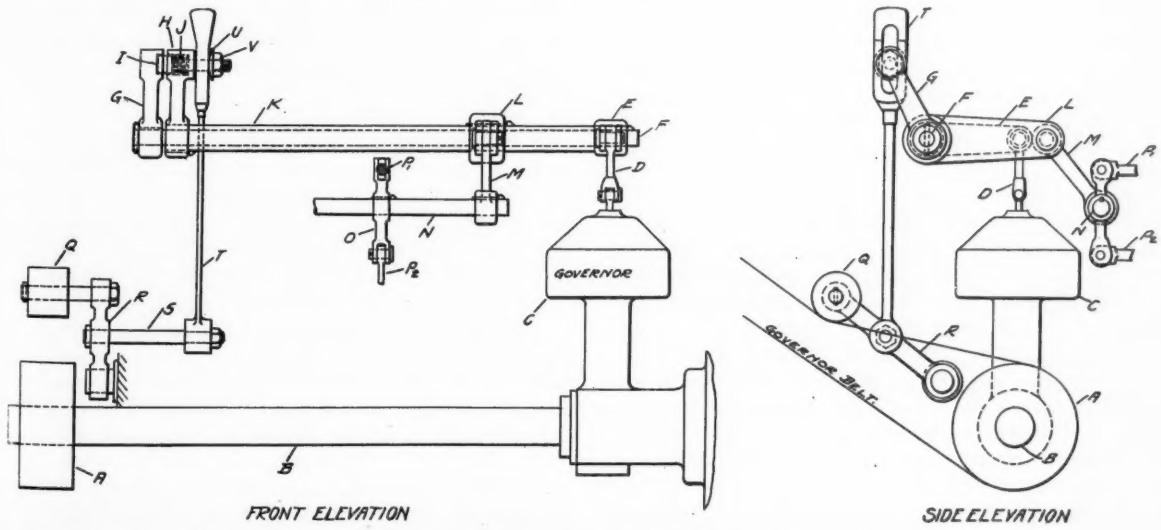


FIG. 1. FRONT AND SIDE ELEVATIONS OF GOVERNOR GEAR

The purpose of this idler pulley, and cam mechanism is to act as a safeguard. If the governor belt should break, the idler pulley Q which is fastened to lever arm

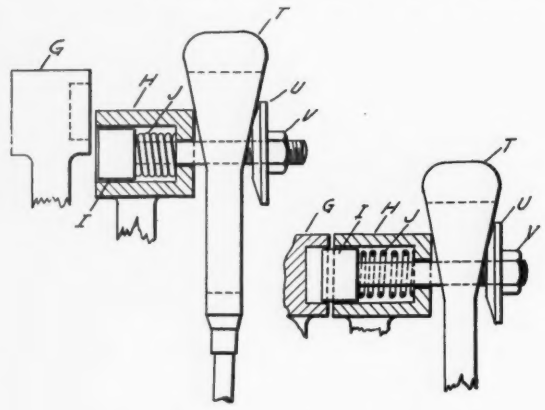


FIG 3 FIG. 4.

FIG. 3. CAM IN FALLEN POSITION; HEAD OF BOLT DISENGAGED; STEAM CUT OFF

FIG. 4. SHOWING HOW NUT HAD SLACKENED BACK ON BOLT FAILING TO DISENGAGE THE HEAD

R by a small shaft, would drop and pull down the slotted cam link T. The beveled cam surface on the link T when in good working order should fall, thereby wedging between lever arm H, and beveled washer U, compressing spring J as shown in Fig. 3. When this beveled cam surface has wedged between the washer, and the lever, it forces the head of bolt I to disengage from lever arm G, and recede into recess of lever arm H. This would allow lever arm H to clear lever arm G, and fall as shown in Fig. 3. Lever arm H being keyed to outer shaft K transmits the movement through shaft K to lever arm L which is keyed to K. Then through M, N, and O the motion is transmitted to the reach rods P_1 and P_2, thence to the cutoff, thereby cutting off the steam and stopping the engine.

Had this governor gear worked as described above, there would have been no trouble, but such was not the case. There are quite a few parts to this governor gear, although it is simple as compared to many others that I have seen. Here is just one small detail that failed to work as it had been designed and which when it failed caused considerable damage.

When the governor belt broke, the idler pulley Q dropped, pulling down lever arm R upon which the slotted cam arm T is pivoted. This cam link dropped as it should, but when the beveled surface dropped to the lowest position it failed to compress the spring J, as the nut V had slackened back on the bolt I, as shown in Fig. 4, hence the two lever arms G and H did not disengage and allow lever arm H to drop.

When this occurred, the governor was useless, and the engine overspeeded, so that before it could be shut down by hand, the main belt had broken, resulting in considerable loss.

This could all have been eliminated had there been a cotter pin or some other locking device to hold nut V in position. The governor gear is just as important as the safety valve or the blowdown pipe on a boiler and these are tried every day by good engineers, so why should they not make a periodic inspection of the engine to see that all parts are tight and in position?

The engineer should study every nut, bolt, or part of his engine. He should know their functions and see that all things are kept tight and in place, especially the governor gear, as the safety of everyone in the vicinity of the engine is dependent on it.

Mutual Benefit Associations in Industry

OUTLINING THE PRINCIPLES WHICH MAKE FOR THE SUCCESS OF AN ASSOCIATION OF THIS TYPE. BY FREDERICK A. ANDERSON*

I HAVE BEEN asked to write on the general subject of benefit associations and to tell in detail what the Twin City Lines of Minneapolis and St. Paul are doing along this line. It is exceedingly difficult for me to tell about an organization with which I have lived so intimately for the last six years. I feel as if someone were asking me to tell about my own child, which would be a very difficult thing to do, and yet, I know all about my own child.

We organized our association in the month of February, 1915. It has grown and its scope of activities has increased as the need has been felt. The foundation, which was laid at the beginning, has been sufficiently strong to support the additional features that we have added as the association has developed.

Before discussing the details of our association, I want to express my conviction regarding certain fundamentals which should be given serious consideration before any firm attempts to organize this type of work. The first of these principles is that no association, however wonderful its provisions may be, will ever amount to anything worth while if the spirit and purpose of the employers back of it are not right. I mean that the concern cannot neglect or ignore adverse conditions under which men work; it cannot consider men as mere cogs in a machine or stand for anything else than a square deal in all its relationships and "hand out" an association and expect it to be favorably considered by the employes. No amount of advertising or talk will ever convince the employes that the concern is on the square. They must feel the spirit of the organization in their everyday relationships with the men who give orders. In other words, I believe it requires the incarnation of human interest, squareness and justice throughout the entire organization to make any plan of cooperation or social service acceptable.

The second principle is that the management of the association should be mutual, both employer and employe being personally represented in the management and contributions to the undertaking. The fact that the management of the association is mutual will guarantee open and aboveboard policy on the part of all concerned, which will in itself, insure mutual confidence. It will also mean that the association will be more attractive to the employes.

* Social Service Director, Twin City Lines, Minneapolis and St. Paul.

Some time ago a thorough study of benefit associations was made and it was found that in associations where the employes operated the association without co-operating with the management, there were but 30 per cent of the employes in the membership, while in the associations where the management was a mutual affair, the average membership was 65 per cent of the employes. Mutual management will develop an understanding between the officials and employes of the company and nothing is more essential to the success of the undertaking than the creation of what may properly be called family spirit, and further, mutual management will permit of a larger program, which in itself will demand greater favor from the employes.

The third principle is that the membership should be voluntary. Compulsory membership is likely to lessen whatever interest there may have been in the organization at the outstart. It is apt to create a misunderstanding of the real purpose of the association. It is usually the case where the membership is compulsory, that the individual who has charge of the actual management of the activities, will be of the dictatorial type. This means that if there is not already a breach between the management and the employes, the chances are that there will be soon. There may be exceptions to this, but I am convinced that it is treading on very dangerous ground. The membership will not be so apt to feel that they are contributing toward their own association. They are apt to feel that the dues are burdens which they are bearing because they have to. If these things be true, the value of the association both to the concern and to the employes will be of a negligible quantity.

The fourth principle is that the association should be thoroughly organized and the plan of organization and the provisions made so plain and explained so thoroughly that there will be no chance for misunderstandings among the employes, as to the purpose and activities of the association.

The fifth principle is that the plan must be an adequate one, or at least as nearly so as it can be made. I have known of organizations with such limited benefits and meager provisions that they were fairly despised by the men. I shall go more into detail as to what I mean by the association plan being adequate as I discuss in detail the activities of our association.

The sixth principle is that the program of activities of the association must be constructive and thorough.

Family Spirit an Important Factor

From the very beginning of our company, the family spirit has been evident. The first organizers of the Twin City Lines felt that what was good for one ought to be good for all, and that those things which were bad for one were bad for others. It was their conception that if everyone in the organization worked together, they could produce the best street railway system in the country. Wages, hours, working conditions, physical equipment and the personnel of the organization have consistently been kept at the best level that the company could maintain throughout its entire existence and after eight years of closest association with this concern I am convinced that the splendid family spirit is being realized more today as an actual factor than ever before. This applies both to the management and the employes throughout the organization.

As I stated at the outstart, our association organized in February, 1915, upon a mutual plan of management. The employes are represented by nine members of their own choice and the company is represented by nine officials. This composes the executive committee, which has the final word in matters concerning the association as a whole, or any individual matter which may be appealed to this body. After a very thorough study, covering a period of more than a year, the executive committee adopted a constitution and by-laws. Since its adoption the executive committee has made amendments to the constitution as the development of the association required. There is also a benefit and relief board, which is composed of nine employes' representatives and three officials of the company. This board considers, investigates and passes upon any claims where there are any questions raised. Associated and co-operating with each of the nine employe representatives there is a departmental committee of three and these, as well as

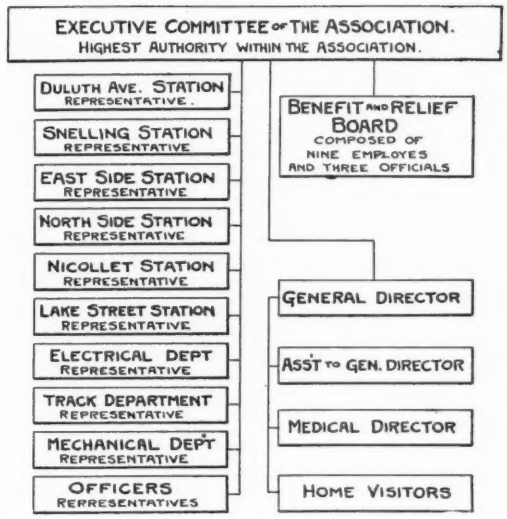


FIG. 1. PLAN OF ORGANIZATION, EMPLOYES' MUTUAL BENEFIT ASSOCIATION

the representatives, are elected by the employe members. They have charge of all social, education and physical activities. They also represent the division which elects them in matters pertaining to working conditions, hours, etc. This last phase of the work of the committee heads up in a co-operative committee which functions separately from the benefit association and has its own constitution and by-laws.

Financial Arrangements are Mutual

The financial arrangement of the benefit association is also mutual. The members pay an entrance fee and dues which are deducted monthly from their pay checks. The company pays an equal amount of all dues paid by members and, in addition to this equal amount, pays the salaries of association officers, physicians, home visitors and clerical help, also cost of consultations, X-rays, medical supplies, office rent, printing, etc. Last year this meant that the company paid 65 per cent of the total budget while the members paid 35 per cent. The executive committee appointed the treasurer of the company to act as treasurer for the association, but the

money of the association is kept in a separate bank under a separate account. Our experience has proven that the mutual nature of the organization has produced an increase of that family spirit which is so essential. It has meant genuine co-operation.

When the organization was started, the membership was thrown open for three months for charter members. After that time the membership was restricted to those who were within the age limit, who were physically fit and who had been in the employ of the company two months or more. No one is coerced or ever urged to join the association by any official of the company. The membership is maintained principally by the good standing of the association among the members and by the activities of the association committees in promoting the work. The average membership, since the organization of the association six years ago, has been about 70 per cent of those eligible to membership. The members are kept posted as to what the association is doing by monthly reports and by an annual report which is printed and distributed to all members.

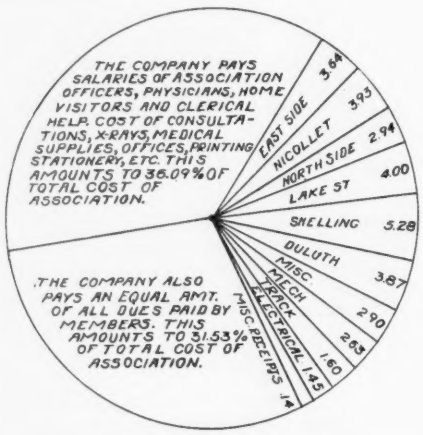

THE COMPANY PAYS SALARIES OF ASSOCIATION OFFICERS, PHYSICIANS, HOME VISITORS AND CLERICAL HELP, COST OF CONSULTATIONS, X-RAYS, MEDICAL SUPPLIES, OFFICES, PRINTING STATIONERY, ETC. THIS AMOUNTS TO 38.09% OF TOTAL COST OF ASSOCIATION.
EAST SIDE 3.64
NICOLLET 3.93
NORTH SIDE 2.94
LAKE ST 4.00
SNELLING 5.28
DULUTH 3.87
MISC 2.90
MECH 2.63
ELECTRICAL 1.60
MISC RECEIPTS 1.45
THE COMPANY ALSO PAYS AN EQUAL AMT. OF ALL DUES PAID BY MEMBERS. THIS AMOUNTS TO 31.53% OF TOTAL COST OF ASSOCIATION.

FIG. 2. THE PERCENTAGE OF TOTAL COST BORNE BY DISTRICTS AND BY THE COMPANY

The following are the dues and benefits, also the negotiations regarding entrance to the association:

Class	Rate of pay (Ages 18 to 45)	Monthly Dues	Weekly Benefits	Death Benefits
A-A	$200 to $300 per mo. . .	$1.35	$17.50	$700
A	$100 to $200 per mo. . .	1.05	14.00	600
B	$60 to $100 per mo. . .	.75	10.50	500
C	Less than $60 per mo. .	.45	7.00	300
	(Ages 45 to 50)			
D	$100 to $300 per mo. . .	1.35	14.00	300
E	$60 to $100 per mo. . .	1.00	10.50	225
F	Less than $60 per mo. .	.65	7.00	150

Medical Service

If an applicant for membership has a physical defect which can be remedied by surgery or medical care, an exemption is taken covering that defect. This exemption holds good for two years, at which time it is cancelled and the member becomes a full fledged member. If, during this two-year exemption period, the member chooses to have an operation performed, he pays for this himself, but the association reimburses him for the cost of that operation when the term of the exemption expires.

It is almost a threadbare statement to say that a man's greatest asset and really his working capital is his health. It means everything to him. It is the basis of his efficiency; in fact, it is the very foundation of industry and society. Life is most sacred; therefore, anything that tends to undermine it is vicious and destructive. To prevent sickness and to conserve health guarantees to the individual freedom of heart, efficiency and happiness.

The more I see of health work the more I am convinced that it must be the best. Dr. Cabot is quoted as saying that there are two classes of people that receive good medical service—the rich and the extremely poor. The rich can afford it and get it, while the extremely poor make use of the free clinics which are maintained by the best medical men in the community. In our work, we are dealing with the middle group. This group, throughout society generally, receives limited and mediocre medical service. By grouping large numbers together in the association in a co-operative mutual plan, it is possible to bring to this great group of the very best citizens in our land the high type of medical and surgical service that is needed.

In our plan of organization providing for medical needs, we have 10 places where members may receive medical attention. In most of these the physicians are on duty one hour each day, while at our general medical director's office there is a physician in constant attendance during the day. Last year 53 per cent of all members of the association called on our medical staff for some service. This 53 per cent made 10,298 calls, or an average of 6.7 times during the year for each individual call. Someone recently criticized our plan for making the physician so easily accessible to the membership, but I will prove to you in figures showing the decreased time off for members who are disabled, that it pays to have the physicians where they can be seen as often as the member chooses to call. Of course, the physician needs to head off tactfully the neurotic who comes only to satisfy his imagination, but we have very little difficulty along this line.

In many concerns the medical director does everything. He makes the examinations, he treats sickness, performs operations, etc. We believe that our plan more adequately meets the needs of the members. The medical director or his associate, who usually passes upon all cases where there are complicated conditions, have the liberty of placing the man in the hands of the best specialists obtainable in the line of medical service that is deemed necessary. No one man today can claim to know all about the different phases of medicine. We are living in a day of specialists. It would be utterly impossible for us to finance a proposition which would provide for a group of men who have specialized in these various phases of medical service. Therefore, the medical director has the authority to send any member or dependent member of his family to any specialist whom he deems qualified to pass upon the particular disability confronting him. Such examinations, consultations, tests, X-rays, etc., are paid for as part of the association expense. Last year, with our medical director feeling perfectly free to use such specialists as the varied cases warranted, we spent only

$2253.75. This practice applies to general medicine, to surgery and to dental service. We felt that rather than to have one dentist in our staff, who would maintain a dental clinic, we would use that amount of money in providing consulting dentists. These consulting dentists are specialists in their line. They take any X-rays that are necessary, make thorough examinations of the mouth, do any extract or surgical dentistry that is required and give whatever advice is necessary regarding other work that is necessary or desirable in the mouth. This phase of medical service has just recently been added and is proving to be most beneficial.

This same principle is applied to surgery as well. We believe that surgery should be performed by the very best surgeons available and, therefore, we designate a group of surgeons who are required by their association to pass certain surgical quality tests. While we feel that there are just as good surgeons outside of this association, we have reason to believe that this group is competent to give us high grade work. Mediocre surgery often only handicaps the patient in his endeavor to get well. The association believes in paying the surgeons a good price for their services and, therefore, we can command the very highest grade of work. During the last year, 299 operations were performed, at a total cost to the association of $12,278.42, or an average per operation of $41.06. This includes the cost of both major and minor operations. Our association has felt from the beginning that the family should be considered in planning the provisions of the operation. We, therefore, pay three-fourths of the cost of any operation performed on any dependent member of an association member's family. It would be interesting to note that our surgery has actually produced results. In a study of members who were operated on during a certain year, we discovered that those whose efficiency standing rated 75 per cent or over showed a 3 per cent increase in efficiency, while those below 75 per cent on down to as low as 50 per cent showed an increased efficiency, after a six months' period, of 35 per cent. Therefore, we are convinced that a considerable amount of the surgery we do is corrective in its results. Surgery means an emergency expense that neither the man nor his family can afford, and it is for that reason that we assume this mutual responsibility for the family in this matter.

Payment of Benefits

Our association provides for the payment of benefits ranging from $1 to $2.25 per day for a period of 52 weeks for any one disability. Last year we paid 1183 different sick claims, or a total of $21,274.90. We also paid 47 accident claims, or a total of $1273.32. The average amount paid during the last six years on account of sickness amounted to $22 per individual case.

At the outset of the association, we were warned that men would take advantage and stay away longer than they should on account of being paid benefits. There may be such cases, but I am convinced that the family spirit has so thoroughly found its way through the organization that there is very little reniging. The first year the average length of time off was 18 days, the second year this amounted to 20 days. Then we employed a registered nurse as our home visitor and for the next two years it dropped to 15 days per case. The next year it came down to 13 days and this last year it has been 11.3 days per case. This shortening of absence from duty is largely due to the increased efficiency of our medical service and our plan of notifying, etc.; also the type of medical service which we perform and to the fact that I have mentioned; namely, the increased family spirit throughout the organization.

When the association first started, we did not pay for the first seven days. After trying this for a year, we came to the conclusion that it was not a just plan. Since that time, we deduct only the first two days.

The association also pays for the prescriptions written by our physicians. Special arrangements are made with certain drug stores and by ordering only the very best grade of drugs and only such quantities as are actually needed, we have been able to keep the association price of the prescriptions down to 40c. Last year 1143 prescriptions were written at a cost of $1161.03. The association also pays for all medical appliances that are ordered by our physicians.

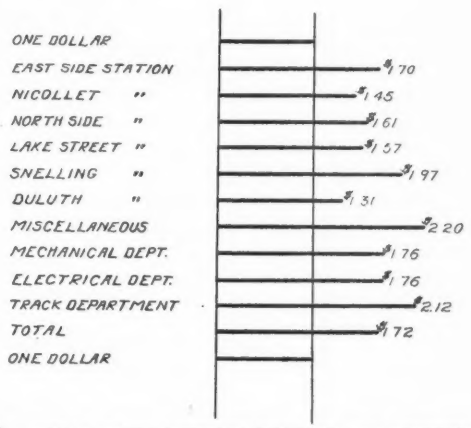


FIG. 3. WHAT EACH DISTRICT RECEIVED IN BENEFITS FOR EACH DOLLAR PAID IN

It is our belief that benefits should be paid for a long enough period to determine whether the illness is to be permanent or not. By paying benefits for a full year, when necessary, it gives us a chance to help the man make such readjustments in his home as are usually necessary when the bread winner becomes permanently disabled.

It is hard sometimes to determine the actual value of such things, but I feel that the man who drags around the shop or the office with perhaps a slight fever is performing an inferior type of service and his efficiency is reduced materially. The proper medical service heads off this sort of thing for the man has easy access to the doctor and it is far better for such a man to be sent home for a day than to do half work for several days and finally have to give up and probably remain at home a longer time. Proper medical service should also insist upon the man not coming back to work until he is well. The man who comes back partially recovered will do only a mediocre service. Proper medical service is required of the member while he is off duty. Proper medical service will lessen the number of men who pretend to be sick. On the whole, medical service will shorten the absence and the total number of days lost by employes over a period of time.

Our association also pays death benefits ranging from

$150 to $700, according to the class of membership held. In the last six years, 98 members have passed away and their beneficiaries have been paid an average of $478.57.

The association feels that it has a mission in the home as well as to the employe on duty. In 1917, we employed a registered nurse as our home visitor. Two years ago, it was necessary to add another nurse and last year they were called into 710 different homes, making a total of 4081 visits. They deal with emergency needs of all sorts. They give pre-natal and post-partum instruction. They discover the incipient illnesses in the child or the mother. They help in time of surgical operations; they help adjust matters in the home when either of the parents is taken away. These nurses have the freedom of calling for any special medical aid that is needed in any emergency that they come in contact with.

It is the practice of the general director of the association to call upon every member who is sick for a period of a week or more, and the welcome that is extended to those in charge of the association as they go to the homes is prima facie evidence of the way the members feel toward their own organization.

The association staff composes what might be called a general service bureau. Last year more than 1300 persons called on the general director for varied services and advice. One can hardly conceive of any human problem which has not been dealt with through this service bureau. In many instances where unexpected emergency expenses have come into the home, it is necessary to lend the employe money. In every such instance, the matter has been thoroughly investigated and almost invariably there are other services more important than the lending of the money which is needed.

The association, through its committees, conducts activities such as parties, tournaments of various sorts, health talks, educational work, Americanization work, etc.

When employes are proud of their association it follows as sure as night follows the day that they will be proud of the company that is standing with them back of the proposition. During the six years of our association, we have paid in actual benefits the sum of $268,511.30. In addition to this sum the company has paid $130,062.47 for medical service, nurses, consultations, etc., which means that the average budget for the last six years has amounted to $66,428.92.

The company provides old age pensions which members of the association are eligible to receive, but the entire expense of this pension system is met by the company out of its current expense account. I shall not go into detail regarding this matter.

In closing, I would say that the whole association spirit and the primary cause for its success rests upon the fact that we can't get away from the truth of the golden rule. When "We do unto others as we would be done by," success is sure to come and satisfaction and the spirit of service is sure to follow.

Heat Balance Systems

Describing the Operation of the House Turbine Method of Auxiliary Drive. By F. C. Chambers and J. M. Drabelle

THE problem of maintaining constant temperature boiler feed water, regardless of load and irregular rates of feeding, is of the greatest economic importance in the operation of a power plant. If boiler feed water can be maintained at approximately 212 deg., before going to the boiler or economizer, the maximum steaming capacity of the boiler plant can be realized. High feed-water temperature also reduces the amount of dissolved air in the feed water, which has a marked effect upon the corrosion of drums, headers and tubes in the boiler.

Methods of Auxiliary Drive

Several methods of maintaining constant feed water temperatures have been proposed, among which may be enumerated the following:

1. Steam driven auxiliaries used entirely, exhausting into open feed-water heaters.
2. Mixed steam and electrically-driven auxiliaries.
3. Method of bleeding steam from intermediate stages of main turbine by means of flow valves.
4. Combinations of the above systems.
5. The house or auxiliary turbine system.

Each of the systems enumerated possess certain advantages and disadvantages, which are more or less well known and with the exception of the last system, will not be discussed here. The last system, i. e., the house turbine system, possesses distinct advantages over the others and has proved successful in actual practice.

The House or Auxiliary Turbine

A house or auxiliary turbine is used in generating stations in which all of the auxiliaries, except the boiler feed pump, are electrically driven. In one system a condensing turbine is used, exhausting into a barometric condenser through which the condensate from the main generating unit passes. The heat from the exhaust steam of the turbine is absorbed by the condensate. This system does not answer the requirements of maintaining a constant feed-water temperature at all times, unless some method is provided to vary the load on the auxiliary turbine. The amount of load taken by the auxiliary turbine will vary according to the quantity of water to be heated, both condensate and make-up. Some auxiliary device, therefore, is necessary to vary the load on the turbine. An added complication of this scheme is the piping, which must be so arranged as to allow the supply of make-up water to be delivered into the condensate line between the condensate pump of the main turbine unit and the barometric condenser.

The other system of auxiliary turbine proposed and placed in actual operating service, is the non-condensing turbine, exhausting into an open feed-water heater. In this system all of the auxiliaries, excepting the boiler feed pump, are electrically driven. The auxiliary turbine is electrically connected to the main generating bus of the station through a bank of step-up transformers. In order to take care of the variation of steam demands on the auxiliary turbine, the load on this turbine is varied by means of an automatic controller.

To the piston of this automatic controller is connected one end of a flat spring, the other end being attached to the bell crank operating the admission valve to the turbine. The piston is actuated by water pressure supplied from the house system. The pressure for actuating the diaphragm of the controller is taken from the main auxiliary exhaust header at a point about 20 ft. from the turbine, so that this pressure remains practically constant under balanced conditions and is not influenced by a sudden change in load of the auxiliary turbine.

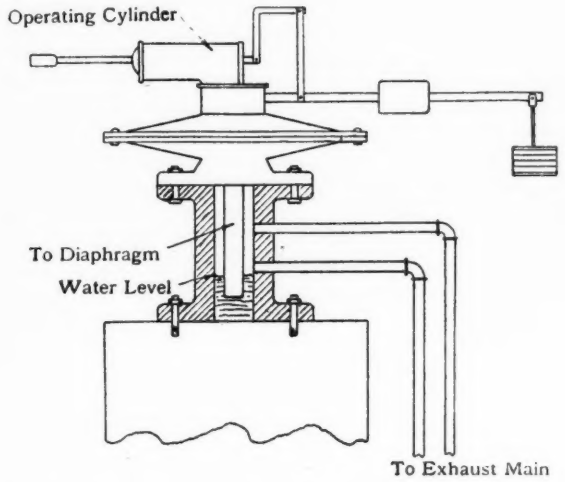


FIG. 1. HORIZONTAL TYPE HOUSE TURBINE CONTROLLER

To illustrate the operation of this controller, assume the following conditions: Load on main generating units 4000 kw.; water being supplied to heaters by condensate pumps at the rate of 80,000 lb. per hr.; load on auxiliary turbine to supply the necessary steam to raise the temperature of the feed water from 50 to 215 deg., 150 kw.; pressure on auxiliary header, one lb. gage. Now assume that, due to a sudden change of load to 6000 kw. on the main units, such as constantly occurs in central stations supplying either an exclusive railway

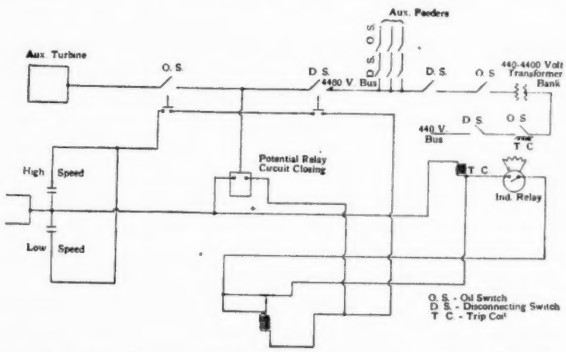


FIG. 2. SCHEMATIC DIAGRAM OF AUTOMATIC PROTECTION FOR AUXILIARY TURBINE

load, or a combination lighting and railway load, the amount of condensate to the feed-water heaters is increased from 80,000 to 110,000 lb. per hr. In order to maintain the temperature of the feed water constant, or nearly so, it will be necessary to increase the quantity of exhaust steam from the auxiliary turbine in approximately the same ratio or about 40 per cent.

The auxiliaries of the station will require practically no additional power under the increased load conditions. It is evident that, if sufficient steam is to be furnished from the auxiliary turbine to heat the increased amount of condensate to a maximum temperature, the load on

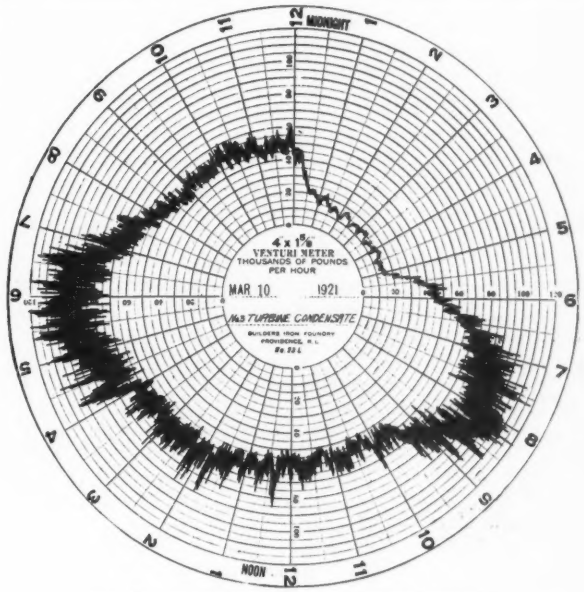


FIG. 3. VOLUME RECORD OF CONDENSATE

the auxiliary turbine must be correspondingly increased. This is accomplished in the following manner:

When the quantity of condensate is increased from 80,000 to 110,000 lb. per hr., the result is a slight reduction in pressure on the auxiliary header. This is

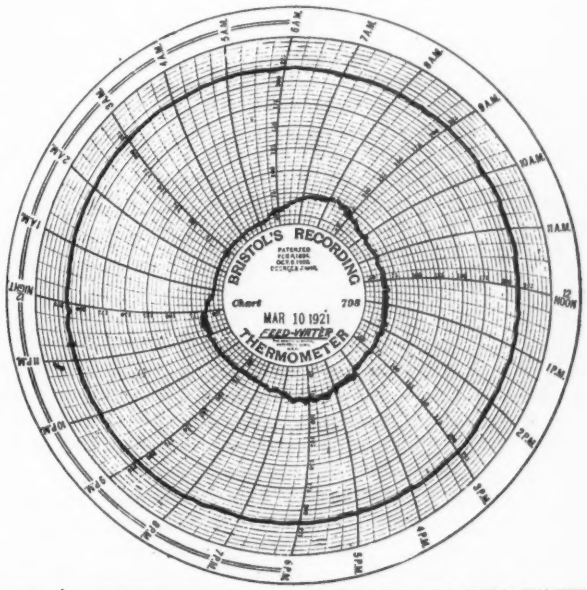


FIG. 4. TEMPERATURES OF CONDENSATE AND FEED WATER

because the auxiliary turbine is not supplying sufficient steam to maintain 1 lb. pressure on the diaphragm of the controller, which will therefore move. This movement operates the pilot valve, admitting water to the cylinder of the controller. The tension on the auxiliary spring between the controller and the bell crank actu-

ating the admission valve to the turbine is increased, increasing the steam flow into the turbine. The additional load is built up through the bank of step-up transformers between the auxiliary bus and the main bus. Under these conditions, that is with a load of 6000 kw., the auxiliary turbine is now delivering 150 kw. to the auxiliaries and approximately 75 kw. to the main bus. This condition of balance both in electrical load and steam supply for heating the feed water remains constant until another change takes place in the load.

Protective Features

Because the house generator runs in parallel with the main station bus, it is imperative that adequate protective devices be provided so that in case of any abnormal disturbances, the auxiliary turbine may be promptly cut off from the main generating bus, thereby permitting a continuous and uninterrupted operation of the auxiliaries. This is accomplished as follows:

1. In case of rise in frequency on the main generating bus, it is essential that the auxiliary turbine trip out the bus tie switch before the over-speed device on the auxiliary turbine may operate. This form of protection is secured by an overspeed switch on the shaft of the auxiliary turbine opening the main tie-switch between the transformers and main generating bus.

2. To prevent trouble from a reduction in the main generating bus frequency, due to either overload or high-tension disturbances on main bus, an under-speed switch is also incorporated. This device is mounted on the end of the turbine shaft so that in case of a frequency lower than normal, the bus tie switch will operate.

If the station bus voltage is maintained by a Tirrill regulator, the frequency could become very low before the contacts of the control equipment would open. A further object of the underspeed switch is to prevent the slowing down of the auxiliaries, including the motor driven exciter, in case of a reduction in the frequency of the main bus. This also prevents the lowering of the frequency of the auxiliary turbine, preventing the dropping out of the contactors under this condition. The idea of the under-speed device is to keep the auxiliaries, including the motor driven exciter, up to speed at all times and to enable the auxiliaries to be kept at a normal speed, in case of low steam pressure when it is desirable to hang on to the load.

3. Low voltage on the main generating bus is taken care of by potential relays. These will close their contacts in case of low potential, thereby energizing the trip coil of the bus tie switch, cutting the auxiliary turbine free from the main generating bus. If this condition was not taken care of the auxiliaries would drop out.

4. Should the auxiliary turbine be shut down for repairs or overhauling, power for the auxiliaries is taken from the main generating bus. In this case interlocks are provided oon otohe disconnecting switches and oil switches to prevent the operation of the main bus tie switch. Interlocks are also provided on the disconnecting switches to permit the station operator to test out the oil switch with the disconnecting switch open, before synchronizing the auxiliary turbine with the bus.

5. High current protection is taken care of by induction type relays set for approximately 300 per cent normal current and five seconds delay. These relays are practically inoperative, except in case of short-circuits on the auxiliary bus.

The charts from the recording instruments of the Des Moines City Railway station shown in Figs. 4 and 5 illustrate the actual operation of this system. These two charts clearly show that the application of the auxiliary turbine, with control devices as mentioned, is not only correct in theory, but in actual practice.

—The Electrical Journal.

Pistons Without Piston Rings

The Ringless Piston Made Possible by Correct Shaping of Piston Head Gives Excellent Results in Automobile Engines. By S. H. Bunnell

THE pistons of single-acting internal combustion engines of all sizes serve the double purpose of piston and crosshead. As a piston, they have been fitted slightly smaller than the diameter of the cylinder bore, and provided with snap rings to prevent the passage of gas. As a crosshead, the surface of the ordinary piston is faulty because it is broken by piston ring grooves, and the ridges formed by the piston rings, and by the piston pin openings. The crosshead ought to have a smooth unbroken surface fitted closely to the cylinder in which it slides; however, the motor car piston, due to its distortion when heated, is purposely relieved around the piston pin bosses, and tapered at the upper end, so that when these parts expand by excessive heat, they will not project sufficiently to bind the piston in the cylinder.

The ringless piston is the invention of Paul G. Tismer, a mechanical engineer with long experience in connection with internal combustion engines. He reasoned that if a piston could be produced which would not expand irregularly when heated, it would run gas-tight on the oil film which should always be present on the cylinder walls of a splash oiled engine. Accordingly, he worked out various designs for pistons, with the principle common to all of a center carrying the piston pin bosses, and forming a domed or concave piston head, and a separate shell of uniform thickness, screwed to the piston center at one or both ends.

Pistons of this type were made by Mr. Tismer more than 5 yr. ago, and operated for several years in test engines. His reasoning proved correct in every particular. By shaping the piston head into either domed or concave form, the metal of the piston head meets the wall of the piston center at an angle, and does not exert the same amount of radial expansive force which is exerted by the usual flat piston head. The thin shell of the piston running in close contact with the oil film on the cylinder wall remains comparatively cool under all conditions, and does not distort. It has been found possible to overheat the whole engine to the point of boiling the jacket water continuously, and yet without the slightest reduction of power produced, or damage to the cylinder walls.

Accompanying Fig. 1 shows a section of the ringless

piston as first developed for the Ford automobile. It is composed of a center forming the piston head and carrying the bosses which support the piston pin; and a cylindrical shell about 1/16 in. thick, secured to the center by a screw thread at its upper end. The weight of the piston is less than the weight of the standard Ford piston. It can be interchanged with the present Ford piston without alteration in any other part. The effect of the ringless piston in the Ford engine is to increase the power of the car, as has been perceived instantly by everyone who has driven the Ford car with ringless pistons, and compared it with the performance of standard Ford cars.

Piston ring friction in the automobile engine is a cause of loss of power. Anyone who has fitted a new piston to a cylinder knows that the piston pushes in stiffly, and can readily appreciate the constant drag caused by the piston with its spring rings, running three idle strokes for one power stroke. If a piston without rings, slipping freely into an oiled cylinder be substituted for the ordinary piston, the frictional loss must be reduced to a small fraction of the piston ring friction. It would therefore be expected that the ringless piston would have advantage in point of power produced by the engine.

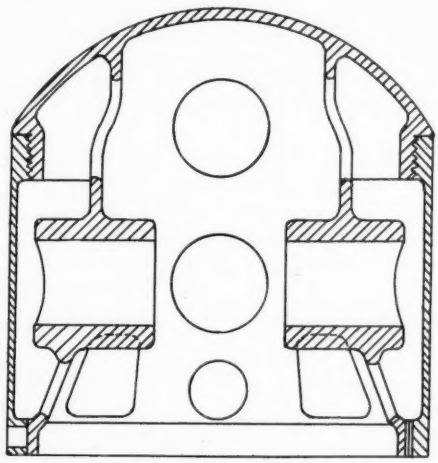


FIG. 1. SECTION THROUGH RINGLESS PISTON FOR FORD ENGINE

Road tests are after all the best measure of the performance of automotive engines. A Ford car equipped with ringless pistons has been driven over all kinds of roads, and up the steepest road grades; it has been raced against standard Ford cars on many occasions, and invariably passes them with the greatest ease. The car was put in the hands of the chief engineer of a motor car works, was purposely overheated to the boiling point, and was then driven to the top of Wilbraham Mountain in Springfield, Mass., without the slightest difficulty. It was immediately put through further road driving under severe conditions, and it was found on this and other occasions that it was impossible to overheat the engine to the point of causing the piston to stick or cut.

In addition to the friction saving, tests show that there is entire absence of spattering of oil into the cylinder head space to cause carbon and smoke; that there is no sign of the carrying of gasoline down into the crank case to thin the oil; that the speed of the car is considerably increased; that gasoline consumption per mile is reduced; that lubricating oil required is lessened, and that replacement of the crank case oil due to thinning by gasoline is deferred indefinitely, as there is no perceptible change in the quality of the crank case oil under any conditions of operation.

Careful study by experienced engineers devoted to the possibilities of the ringless piston indicates that it will be a factor of the greatest importance in the future development of engines burning kerosene, fuel oil and other heavy residues. The ringless piston cannot scrape the oil off the cylinder walls, and tends to retain a temperature not higher than the cylinder wall temperature, due to its large surface contact. The ringless piston

FIG. 2. STANDARD AND RINGLESS PISTON FOR FORD CAR

therefore makes it possible to run engines much faster than usual, to develop more power through more perfect combustion, to reduce the consumption of lubricating oil, and to do away entirely with the danger of cutting and scoring cylinder walls through the formation of carbon. As internal mechanical troubles have been a big difficulty in the way of improving the present standard type of gasoline burning engine, the use of the ringless piston seems likely to open the way to the successful development of both small and large engines that will have advantages over the present types.

BECAUSE it had served its purpose, a brick chimney, 250 ft. high, reputed to be the tallest in Massachusetts, was felled on July 1 in East Cambridge. This stack was erected in 1851 by the old New England Glass Works. Its diameter at the base was 24 ft. and at the top 15 ft. and it had a 9-ft. flue. It weighed 3431 tons and contained 1,055,754 bricks. The chimney was brought down in a manner similar to that employed in felling forest giants; a V notch was cut into one side of the base until a condition of unbalance was reached when the chimney measured itself on the ground. The fall was accompanied by little noise and only a slight tremor.

According to the vice-president of the company in charge of the demolition, the chimney was of unusually thorough construction and the method of laying the bricks and the material of the bricks are not equaled these days. It is of interest to note that cement was used as the bonding agent, in view of the fact that some authorities state that cement was not known in those days. The quality of the cement was so good that it took a crew of six men more than a week to chop out the hole in the base.

Daily Records

THE KEEPING OF ACCURATE RECORDS IS ABSOLUTELY ESSENTIAL IN THE CORRECT OPERATION OF AN INDUSTRIAL POWER PLANT. BY CLAUDE C. BROWN

ONE OF the most essential duties of an organization controlling the operation of an industrial manufacturing concern is the keeping of accurate records of operation, together with an intelligent history of the advantages attained through improvements made in methods, materials and personnel. In order that such records may be quickly and permanently recorded, it is necessary to supply simple though adequate means whereby the persons who are most fitted to make such entries may be trained to follow a system, and in so doing keep a complete up-to-date record.

Too often records are kept in a haphazard manner, and when a time arrives when reference must be made to them, they are found to be valueless, a mass of non-essential information that is often incomplete and inaccessible.

In this article a number of forms are illustrated which are in actual use in a Western industry and their use and purpose described.

BOILER ROOM LOG SHEETS

AS AN EXAMPLE of a complete and continuous record of operation, let us take the log kept in the boiler room in this plant. The steam generating equipment consists of an almost automatic installation of modern oil burning boilers, equipped with the latest auxiliaries and automatic devices, a description of which was recently published in these columns.

POWER PLANT DAILY GENERATING REPORT

DATE ..... 19.....

MAX. KW. DEM	AVE. KW. DEM	GENERATOR	K.W.H.
		1	
		2	
		3	
TOTAL KWH. GENERATED			

OUTSIDE SERVICE METER READINGS	EAST	WEST	K. W. H.
PRESENT			
PREVIOUS			
CONSUMED			

MACHINE TEMPERATURES

TIME	No. 1	No. 2	No. 3	No. 4
8				
4				
12				

DEMAND

MAXIMUM K. W.	MAXIMUM H. P.	AVERAGE K. W.	AVERAGE H. P.

K. W. HRS. PER H. P. OF DEMAND

BEARING TEMPERATURES

TIME	No. 1	No. 2	No. 3	No. 4
8				
4				
12				

REMARKS

COOLING SYSTEM

TIME	No. 1	No. 2	No. 3	No. 4
8				
4				
12				

EMERGENCY TRIP TEST

TIME	No. 1	No. 2	No. 3	No. 4
8				
4				
12				

LOAD FACTOR	STATION FACTOR
AV. POWER	AV. LOAD
MAX. DEMAND	RATED CAPACITY

ELECTRICAL ENGINEER

FIG. 5. DAILY GENERATING REPORT; REPRESENTS A SUMMARY OF FIG. 4

This copy for Chief Engineer's Office

BOILER ROOM LOG

SHIFT NO._____ FROM_____ TO_____ 192__

Time (Every Two Hours)	Boiler	1	2	3	4	5	6	7	8	9	10
Steam Pressure, pounds, gauge	Hours in Service										
Temp. Feed Water lv. F.W.Heat. °F.	Dusted (Time)										
" " " lv. Economizer 1, °F.	Blown (Time)										
" " " " 2	Draft										
" " " " 3	CO_2										
" " " " 4	Economizer	1	2	3	4	5	Blow Off Tank Reading				
" " " " 5	Hours in Service									Rod	
Temp. Flue Gas leav. Boiler 1, °F	Scraper Start						Start				
" " " " 2	Scraper Stop						Finish				
" " " " 3	Blown (Time)										
" " " " 4	Draft Outlet						Chimney Draft				
" " " " 5											
" " " " 6											
" " " " 7											
" " " " 8											
" " " " 9											
" " " " 10											
Temp. Flue Gas lv. Economizer 1, °F											
" " " " 2											
" " " " 3											
" " " " 4											
" " " " 5											
Temp. Oil entering Heater °F											
" " leaving " °F											
Steam Press. in Oil Heat., lbs., Ga.											
Press. at F. W. Pumps, lbs., Ga.											

AUXILIARY OIL MEASURING TANKS

Tank No.		Time	Rod	Bbls.	Temp.	Bbls. Corrected
	Start					
	Finish					

OIL USED

Tank No.		Time	Rod	Bbls.	Temp.	Bbls. Corrected
	Start					
	Finish					

OIL USED

Venturi Meter Readings		Flow Meter Readings Steam to Burners	
Time	Reading 1000 Lbs.	Time	Reading
Difference		Difference	

NOTE.—When emptying a Boiler or Economizer no record should be made under "Blow Off Tank Readings."

Fireman

Boiler Room Engineer

FIG. 1. BOILER ROOM LOG FOR EACH SHIFT

BOILER ROOM LOG FOR 24 HOURS ENDING_____ 192__

NOTE—THIS REPORT CONTAINS THE AVERAGE READINGS AS COMPUTED FROM THE SHIFT LOGS

Steam Pressure, pounds, gauge	Boiler No.	1	2	3	4	5	6	7	8	9	10
Temp. Feed Water lv. F.W.Heat. °F.	Hours in Service										
" " " lv. Economizer 1, °F.	Total Hrs. in Service since last Cleaning										
" " " " 2	Draft										
" " " " 3	CO_2										
" " " " 4	Economizer	1	2	3	4	5	Blow Off				
" " " " 5	Hours in Service						Shift No.	Lbs. Blown Off			
Av. Temp. Feed Water lv. Econ.	Draft, Economizer Outlet						1				
Temp. Flue Gas leav. Boiler 1, °F	Venturi Meter Readings						2				
" " " " " 2	Shift No. / Venturi Reading / Temp. °F. / Temp. Cor. / Venturi Cor / Net Lbs.						3				
" " " " " 3	1						Total				
" " " " " 4	2						Above Includes Vaporization Losses				
" " " " " 5	3						Chimney Draft				
" " " " " 6	Total Water to Boilers						Chemicals Used By Booth Purifier				
" " " " " 7	Water Blown Off						Lime	Lbs.			
" " " " " 8	Net Water Evaporated						Soda	Lbs.			
" " " " " 9	Steam to Burners / Lbs. / Shift No. / Oil to Burners / Bbls.						Booths Purifier				
" " " " " 10							Amt. Water Purified: Time / Temp. °F. / Reading			Water Analysis: Grams per gal.	
Av. Temp. Flue Gas leav. Boilers	1 / 1										
Temp. Flue Gas lv. Economizer 1, °F.	2 / 2						Sodium Sulphate				
" " " " " 2	3 / 3						Calcium Carbonate				
" " " " " 3	Total / Total						Difference				
" " " " " 4											
" " " " " 5											
Av. Temp. Flue Gas leav. Econ.											
Temp. Oil entering Heater °F.											
" " leaving " °F.											
Steam Press. in Oil Heat., lbs., Ga.											
Press. at F. W. Pumps, lbs., Ga.											

NOTES—Auxiliary Oil Tank readings should be checked against Main Oil Tank readings at regular intervals. After a cold boiler has been filled with water deduct 46,000 pounds from the amount of water fed to the boilers. After filling an Economizer deduct 25,000 pounds.

Boiler Room Engineer

Chief Engineer

FIG. 2. BOILER ROOM LOG REPRESENTING SUMMARY OF SHIFT LOGS

BOILER ROOM PERFORMANCE FOR 24 HOURS ENDING ..... 192..

A	Oil used	Pounds per hour		See "Oil Fuel" Page 34
B	Water to boilers	" " "		
C	Water blown off	" " "		
D	Water evaporated	" " "		D = B−C
E	Temperature of feed water entering boilers	Deg. Fahr.		
F	Total heat per pound of steam at .....pounds Gage Press.	B. t. u.		See "Steam" Page 123
G	Total heat per pound of feed water entering boilers	"		See "Steam" Page 130
H	Net heat added per pound of steam	"		H = F−G
J	Total heat per pound of water blown off	"		See "Steam" Page 123
K	Net heat added per pound of water blown off	"		K = J−G
L	Total equivalent evaporation from and at 212 °F.	Lbs.		$L=\frac{D\times H+C\times K}{970.4}$
M	Equivalent evaporation from and at 212 °F. per pound of fuel oil			$M=\frac{L}{A}$
N	B. t. u. per pound of fuel oil			
P	Steam consumed by burners	Lbs. per hour		
Q	Gross efficiency (boilers only)			$Q=\frac{D\times H+C\times K}{A\times N}\times 100$
R	Factor of evaporation			R = H÷970.4
S	Net efficiency (boilers only, deducting steam to burners)			$S=\frac{D\times H+C\times K-P\times H}{A\times N}\times 100$
T	% steam used by burners			$T=\frac{P\times H}{D\times H+C\times K}\times 100$
U	Total B. H. P. developed			$U=\frac{L}{34.5}$
V	Number of boilers in service			
W	% rating of boilers			$W=\frac{U}{\text{rating}\times V}\times 100$
X	Temperature of feed water leaving economizers	Deg. Fahr.		
Y	Temperature of feed water entering economizers	"		
Z_1	Rise in temperature of feed water in economizers	"		
Z_2	Temperature of flue gases leaving boilers	"		
Z_3	Temperature of flue gases leaving economizers	"		
Z_4	Drop in temperature of flue gases through economizers	"		$Z_4=X-Y$
Z_5	CO_2 (Averaged from recording charts)	%		$Z_5=Z_2-Z_3$

NOTES—In order to be able to compare the performances of the boilers from day to day, five barrels of oil should be deducted from the total amount of oil used during a day when a cold boiler has been fired up and put on the line. No deduction should be made when starting up a cold economizer. All values given above are the average for the 24-hour period. For purposes of this log, assume dry steam leaving boilers.

Total amount of water fed to boilers per week.....

Amount of purified water fed to boilers per week.....

% purified water to total water fed to boilers per week.....

Power Engineer

FIG. 3. BOILER PERFORMANCE RECORD FOR 24 HR.

Figure 1 illustrates the sheet which is filled out during each of the three shifts during the 24-hr. period of operation. It will be noted that on this sheet are recorded all of the necessary readings of oil used, water evaporated, temperatures, pressures and equipment in service.

FIRE ALARM REPORT

(This Copy for Plant Manager)

Date.....

LINES

Circuit	Amperes	Volts	Gr. Volts	Gr. Volts	Repeater Tested	REMARKS
1						
2						
3						
4						

BATTERIES

CIRCUIT		CHARGING				DISCHARGING				
No.	Group	Time On	Time Off	Hrs.	Amps.	Group	Time On	Time Off	Hrs.	Amps.
1										
2										
3										
4										

BOXES TESTED

Date	No.	Circuit	Date	No.	Circuit	Date	No.	Circuit

REMARKS

Electrical Engineer

FIG. 6. FIRE ALARM REPORT

H. P. & Co. No.	R. P. M. / CIRC. No.	MAKE / TYPE	AMPERES Rated	AMPERES Max.	AMPERES Ave.	CONTROLLER TYPE	CONTROLLER COIL No.	SERVICE
SERIAL No.		PULLEYS BORE	PULLEYS DRIVER	PULLEYS DRIVEN		Ave. H.P.	Frame No.	
STYLE No.								
BEARING NO.		Style Number of Stator Coils				Date Inst.		
H. P. & Co. No.	R. P. M. / CIRC. No.	MAKE / TYPE	AMPERES Rated	AMPERES Max.	AMPERES Ave.	CONTROLLER TYPE	CONTROLLER COIL No.	SERVICE
SERIAL No.		PULLEYS BORE	PULLEYS DRIVER	PULLEYS DRIVEN		Ave. H.P.	Frame No.	
STYLE No.								
BEARING NO.		Style Number of Stator Coils				Date Inst.		
H. P. & Co. No.	R. P. M. / CIRC. No.	MAKE / TYPE	AMPERES Rated	AMPERES Max.	AMPERES Ave.	CONTROLLER TYPE	CONTROLLER COIL No.	SERVICE
SERIAL No.		PULLEYS BORE	PULLEYS DRIVER	PULLEYS DRIVEN		Ave. H.P.	Frame No.	
STYLE No.								
BEARING NO.		Style Number of Stator Coils				Date Inst.		
H. P. & Co. No.	R. P. M. / CIRC. No.	MAKE / TYPE	AMPERES Rated	AMPERES Max.	AMPERES Ave.	CONTROLLER TYPE	CONTROLLER COIL No.	SERVICE
SERIAL No.		PULLEYS BORE	PULLEYS DRIVER	PULLEYS DRIVEN		Ave. H.P.	Frame No.	
STYLE No.								
BEARING NO.		Style Number of Stator Coils				Date Inst.		
H. P. & Co. No.	R. P. M. / CIRC. No.	MAKE / TYPE	AMPERES Rated	AMPERES Max.	AMPERES Ave.	CONTROLLER TYPE	CONTROLLER COIL No.	SERVICE
SERIAL No.		PULLEYS BORE	PULLEYS DRIVER	PULLEYS DRIVEN		Ave. H.P.	Frame No.	
STYLE No.								
BEARING NO.		Style Number of Stator Coils				Date Inst.		
H. P. & Co. No.	R. P. M. / CIRC. No.	MAKE / TYPE	AMPERES Rated	AMPERES Max.	AMPERES Ave.	CONTROLLER TYPE	CONTROLLER COIL No.	SERVICE
SERIAL No.		PULLEYS BORE	PULLEYS DRIVER	PULLEYS DRIVEN		Ave. H.P.	Frame No.	
STYLE No.								
BEARING NO.		Style Number of Stator Coils				Date Inst.		

FIG. 7. MOTOR RECORD SHEET

Figure 2 consists of a summary of the shift logs and represents the averages of readings taken over the

FORM 3089-A Date.....19.....

Motor No. ....Repaired

Location .....

Bearing Gone .....○
Bad Connection .....○
Single Phased .....○
Grounded .....○
Burned Out .....○
Rotor Unsoldered .....○
Overhauled .....○
Painted .....○
Replaced .....○

Fuse Blown .....○
Overload Relay .....○
Low Voltage Release .....○
Starting Coil Burned Out .....○
Compensator Lugs .....○
Switch .....○
Miscellaneous .....○
.....

Was New Motor Oiled?.....

USE REVERSE SIDE FOR REMARKS NAME.....

State cause of trouble.....

TEMPORARILY or PERMANENTLY repaired.....

If replaced, state WHY.....

What is New Motor Number?.....

Where did you take old Motor?.....

.....

.....

.....

.....

.....

FIG. 8. MOTOR REPAIR FORM, FRONT AND BACK

24-hr. period. This sheet is computed and made out by the boiler room engineer after he has checked the shift logs as turned in by the fireman in charge of each shift. This report is then turned in to the power engineer.

information placed on this sheet constitutes the equivalent of a daily overall efficiency test and that by means of this record one can see at a glance the results of the day's operation.

All of these sheets are printed on standard 8½ by

POWER PLANT DAILY SWITCHBOARD LOG DATE.....19.....

TIME	VOLTAGE	FREQUENCY	GENERATORS NO. 1 AMPS.	NO. 1 FIELD	NO. 1 P. F.	NO. 1 TEMP.	NO. 1 K. W.	NO. 2 AMPS.	NO. 2 FIELD	NO. 2 P. F	NO. 2 TEMP	NO. 2 K. W.	NO. 3 AMPS.	NO. 3 FIELD	NO. 3 P. F	NO. 3 TEMP.	NO. 3 K. W.	EXCITERS NO. 1 VOLTS	NO. 1 AMPS.	NO. 2 VOLTS	NO. 2 AMPS.	NO. 3 VOLTS.	NO. 3 AMPS.	SALT WATER-1	SALT WATER-2	CENT. NO. 2	REFINERY-A	REFINERY-B	CENT. NO. 1	MELT HSE.-C	MELT HSE.-D	WAREHOUSE	CHAR HSE. E-F.	2ND FL. CENT	LIGHTING AUX.	P.H.2-BARGE-H	OPERATOR
8																																					
9																																					
10																																					
11																																					
12																																					
1																																					
2																																					
3																																					
4																																					
5																																					
6																																					
7																																					
8																																					
9																																					
10																																					
11																																					
12																																					
1																																					
2																																					
3																																					
4																																					
5																																					
6																																					
7																																					
8																																					

FIG. 4

DAILY OIL STATION REPORT No. _____

FOR ENGINEERING DEPARTMENT DATE_____

	CALOL. ENGINE GAL.	CALOL. CYLINDER GAL.	CALOL. TURBINE GAL.	CALOL. TURBINE H.V. GAL.	CALOL. ICE MACHINE GAL.	CALOL. COMPRESSOR GAL.	TRANSIL OIL GAL.	HOUSEHOLD LUBRICANT GAL.	STANDARD ROLLER GAL.	ELEVATOR WORM GEAR GAL.	CASTOR GAL.	MARINE GAL.	LARD GAL.	MICA GEAR GREASE LBS.	MATCHLESS GREASE NO. 3 LBS.	ACME GREASE NO. 5½ LBS.	GASOLINE GAL.	DISTILLATE GAL.	KEROSENE GAL.	TURPENTINE GAL.	RAW LINSEED GAL.	BOILED LINSEED TOTAL GAL.	TOTAL GAL.
TOTAL USED FROM 1st TO DATE																							
TOTAL USED FROM 16th TO DATE																							
TOTAL USED FOR YEAR TO DATE																							
ON HAND A. M.																							
RECEIVED DURING DAY																							
TOTAL																							
DISBURSED DURING DAY																							
REFINERY																							
PACKING HOUSE																							
CHAR & MELT HOUSE																							
PUMP ROOM																							
BOILER HOUSE																							
POWER PLANT																							
ELECTRIC DEPT.																							
TUBS																							
BAG DEPT. POWDER AND BAR																							
WAREHOUSES																							
SHOPS																							
TOTAL DELIVERIES																							
PRICE																							
AMOUNT																							
ON HAND P. M.																							

SIGNED_____

FIG. 12

FIG. 4. POWER PLANT DAILY SWITCHBOARD LOG

FIG. 12. DAILY OIL STATION REPORT

The power engineer then calculates and records on Fig. 3 the daily performance of the boiler plant from the data recorded on Fig. 2. It will be noted that the

11-in. size paper which is perforated at the margin for permanent binding. They are prepared in pads, gummed at the top so that as many carbon copies can be made as is deemed advisable.

FORM 14 E 1500 7-20

PATTERN CARD

PATTERN NUMBER MATERIAL

NAME EST. WEIGHT LBS.

APPARATUS

STATION

DRAWING No. DATE MADE

No. OF PARTS TO PATTERN No. OF CORE BOXES

No. OF PARTS TO CORE BOX

SECTION No SHELF No.

REMARKS DATE FILED

REQUISITION NUMBER	ORDER NUMBER	DATE SENT OUT	CASTING MADE BY	WEIGHT	DATE RETURNED

FIG. 13. PATTERN CARD, FRONT AND BACK

Power Plant Log Sheets

Figure 4 shows the daily power plant log upon which the operators of the three shifts record the hourly switchboard readings of the power plant. In this case, all three shifts are included in one sheet and readings taken on the three generators and exciters and on the 13 feeder panels.

LAMP RENEWALS

Date..... Time.....

In exchange for burned out lamps, please furnish bearer with the following:

Number Lamps..... Size..... Watts.....

Kind { Carbon..... Mazda..... Daylight..... Station.....

Pump Man ..... Foreman

FIG. 9

PUMP REPORT

Date	Pump Number
Packing	Steam Piston
Steam End	Runner
Valve Stem	Shaft
Water End	Bearings
Plunger	Seal Rings
Water Valves	Couplings
Steam Valves	Pump Clogged
Water Piston	Miscellaneous

Use reverse side for cause of trouble and remarks — Reported by

FIG. 10

OILER'S REPORT

STATION..... DATE..... SHIFT.....

	CALOL ENGINE	POLAR CYLINDER	CALOL HEAVY	LARD	TRANSIL OIL NO. 5	HOUSE-HOLD LUBRICANT	MICA GEAR GREASE	MATCHLESS No. 3	MATCHLESS No. 4	ACME No. 3½	MICA GEAR GREASE				
ON HAND START															
RECEIVED															
TOTAL															
QUANTITY USED															
DELIVERED ON REQUISITION															
ON HAND END															

SIGNED.....

FIG. 11

FIG. 9. LAMP RENEWAL RECORD
FIG. 10. PUMP REPAIR SHEET
FIG. 11. OILER'S REPORT

Figure 5 is a summation of Fig. 4 and in addition shows data on operating conditions for each day.

Fire Alarm Report

Figure 6 illustrates a complete daily record of the operation of the fire alarm apparatus throughout the plant.

Motor Record

In a plant that contains about 700 individual motors, ranging in size from 1 to 300 hp., it is absolutely essential to maintain a complete and up-to-date record.

Figure 7 shows a sheet that is printed on tracing cloth so that at any time a complete set or sets of blueprints can be made which will constitute an accurate motor list. In this connection it might be stated that each motor in the plant has been given a serial number; thus motor No. 10-24 signifies 10-hp. motor No. 24. This individual number is stamped upon a brass tag which is screwed to the motor frame so that the motor never loses its individuality no matter in what service it is placed. It will be noted that this record is very complete.

In order that a complete history of each motor may be made at the time of any repair or change, Fig. 8 is furnished in pad form to all repairmen. On this sheet is recorded the exact repair or change that is made and it is turned in each night to the electrical engineer.

In a similar manner, Fig. 9 is used for lamp renewals.

Pump Record

All pumps in the plant are kept track of in a manner identical with that described for the motors. Each pump is given an individual number which is stamped on a brass tag; thus, C-30 denotes centrifugal pump No. 30 and S-24 identifies steam pump No. 24.

Figure 10 shows a sheet which corresponds to Fig. 8 for motors and on which is recorded all repairs and changes made to individual pumps. A pump list similar to Fig. 7 is kept up to date and blueprinted pump lists are thus made available.

Oil Record

A central oil storage house has been installed in the plant from which measured quantities of oil are disbursed. Figures 11 and 12 illustrate the records that are kept of the use of oils and greases, from which it is possible to keep complete track of the amount of oil used on each station.

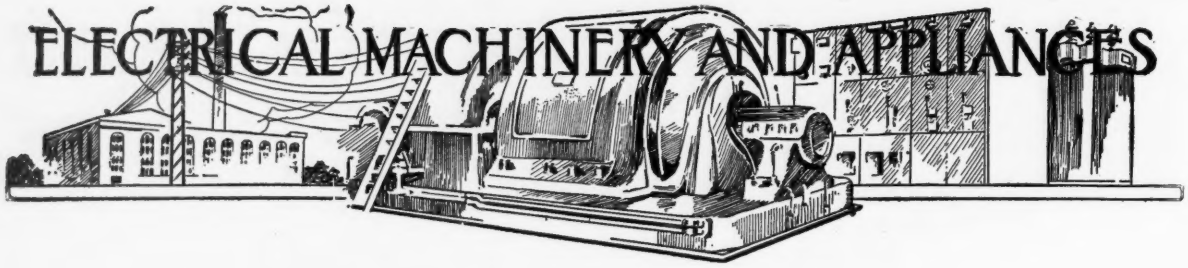
Patterns

Figure 13 shows a concise and complete pattern card which, when properly filed and indexed, forms a complete record of all patterns used.

From a study of the foregoing, it will be seen that each record if properly kept forms a comprehensive though comparatively simple history of the subject covered.

In defeating the proposal for government operation of the Muscle Shoals nitrate and power plant projects, Congress maneuvered itself into a position where it cannot consistently refuse to accept an offer from private interests. Mr. Ford has offered to lease for 100 yr. the completed Wilson dam. On the total additional cost, he proposes to pay interest at the rate of 6 per cent. He offers $5,000,000 for the nitrate plant, the steam plant, lands and other equipment. Secretary Hoover has announced that others are also interested in the Muscle Shoals project. He stated that the Duponts are discussing the matter as well as several chemical and power companies.

The new bill in the Senate and statement by several senators favoring the compulsory adoption of the metric system will probably result in hearings in the near future. Chances are against the consideration of the bill in either House, since Congress would hesitate to take up legislation that may be interpreted as a possible drag on business.



Underground Distributing Systems

SCHEMES OF LAYOUT EMPLOYED; PRACTICAL CONSIDERATION; CABLES. BY E. A. REINMAN

TO UTILIZE electricity commercially, it is usually generated in a central station which is located at a strategic point for the incoming coal, water and discharge of ashes, and is transmitted over wires or cables to the consumer. There are two usual ways of transmission: by overhead wires or underground cables. The overhead system is by far the cheaper in initial cost and is found in many cities. But there comes a time in any growing city when the high initial cost of the underground system is more than counterbalanced by the lack of adequate service, liability of fatalities due to falling wires, fire risk and interruptions to service and then decision is made in favor of underground distribution. Many alert engineers are now looking 5 or 10 yr. ahead and foreseeing conditions, lay out and install an adequate, reliable underground system initially.

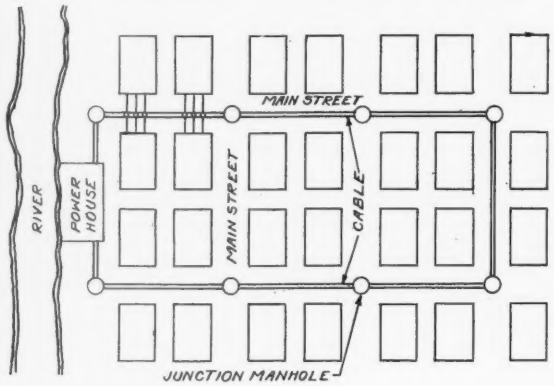


FIG. 1

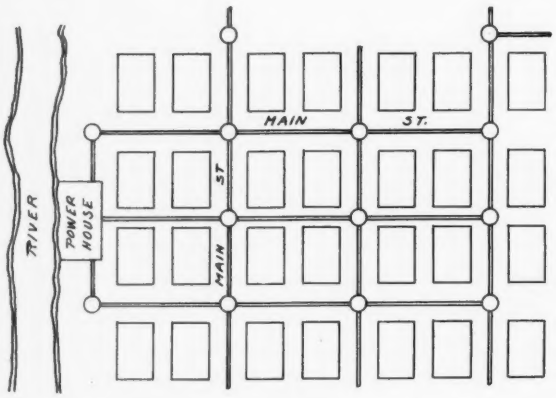


FIG. 2

FIG. 1. SHOWING ORIGINAL RING LAYOUT
FIG. 2. SHOWING ORIGINAL CABLES ADDED TO FORM NETWORK

The design of an underground system is started by an actual survey of power users and a calculation of the ultimate load. This calculation in the past has been done too conservatively as the great majority of systems have grown far beyond original calculations.

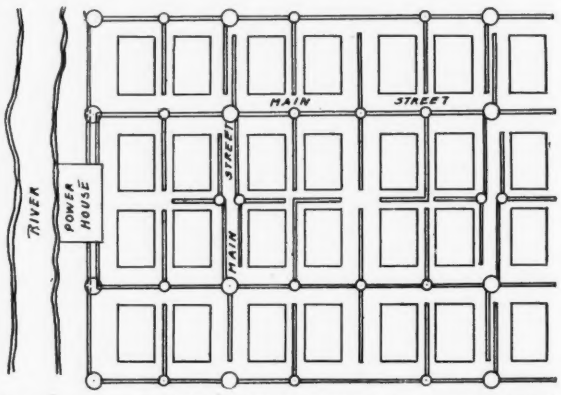


FIG. 3. THE STRAIGHT RADIAL SCHEME OF DISTRIBUTION

The actual load is determined by the maximum demand either by calculation or measurement. The maximum demand on all installations does not always come at the same time, however; nor is the maximum demand always equal to the connected load, varying from 10 per cent in display lighting to 15 or 20 per cent in residence load. Theatres and large buildings may average 70 or 80 per cent of their connected load, while power installations can best be determined by measurement.

Location of the central station is a study by itself and cannot be treated here. Substations also are important, the object of their location being a balance between their initial cost and the cost of energy and copper saved through operating long distances at high tension instead of low.

CLASSIFICATION OF SYSTEMS

DISTRIBUTION systems may be classed in various manners, according to whether they are a.c. or d.c. according to their operating voltages; constant current or constant potential; their phases and frequency.

Direct current systems were formerly much more in vogue than at present. Their principal use is for small distances from the central station to the heaviest loaded portion of the town or city. They were once considered essential for variable speed motors such as are required for printing presses, elevators, etc., and were used in connection with standby batteries to enable a small station to carry successfully a heavy evening peak load. Modern a.c. motor design has eliminated this necessity while the great expense of batteries, both initial, maintenance and deterioration, has caused the design to use sufficient primary equipment. The ease of transformation and metering have turned the balance in favor of alternating current.

Constant current systems have been used, but not successfully, for power transmission. They are still used extensively both a.c. and d.c. for street arc-lamp systems. Present day power and lighting systems employ the multiple or constant potential system almost exclusively.

The voltage of the system requires careful consideration. For high tension distribution between central station and substation, voltages up to 60,000 have been successfully used. There are many factors entering into this selection such as the distance, allowable drop, size of cable load and insulation.

For transmission between substation and distribution centers, 2200 v. is the most common potential, although 1100 v. and 3300 to 66,000 v. are in use. For transmission between distribution centers and the actual load, a voltage of 110 and 220 v. is very common for lighting and small power loads, while 440 v. is common for the larger power loads.

Lighting loads are usually operated at 110-220 v. single-phase three-wire. Power loads are almost invariably operated three-phase or two-phase, as for the transmission of a like amount of power, a three-phase system takes but 75 per cent as much copper as a single-phase system. There are many combination systems such as two-phase, 110-220 six-wire and three-phase four-wire operating 115 v. to neutral and 220 v. across phases; but in general it is best to run two sets of feeders and transformers, one for power and one for lighting, as even under the best of conditions it is almost impossible to operate a motor above 10 hp. on a lighting circuit without causing impaired service.

Three-phase systems are often laid out with oversize cables and two transformers operating in open delta. Then when the load warrants it, a third transformer is added in closed delta, thus increasing the capacity.

Layout of the System

After a careful survey of the ultimate loads, the proposed system is mapped out. The system may be either ring, radial or network. The ring system is often preferable especially for small initial systems. A ring system is shown in Fig. 1, where it will readily be seen that the ring surrounds the congested area of the town, with distributing manholes at important intersections. Now, if trouble develops between any two manholes, this section may be cut out and the rest of the system will still function correctly. In case of further load in the center of the ring additional feeders may be run down the main streets, and the ring may feed outside growing sections, thus turning into a network as in Fig. 2. As the name implies, a radial system is one in which the main feeders radiate from a common center as in Fig. 3. The disadvantage is that a fault on any feeder near the source will render the rest of the feeder inoperative.

Reserve cables are an absolute necessity in underground distribution, as, if a cable fails, it would otherwise interrupt the service until repaired. With the present day protective relays, however, spare cables may be used continuously with decreased cable loss, and in the event of a cable failure, the entire load is thrown on one cable with a slightly higher operating temperature and loss.

The Underground Duct

The design of an underground system centers around the duct, the cable and the manholes and handholes. Many different kinds of ducts have been tried.

Fig. 4. Typical installation of fibre conduit

The original was Edison's copper tubes with embedded conductors. Creosoted pump logs were tried extensively, but were unsuccessful, due to quite rapid deterioration and the great fire risk due to their inflammability during short circuits on the cable. Concrete pipes have been tried, but the breakage during handling and installing is quite excessive. Present practice has narrowed down to clay or terracotta pipes and fiber conduit, both of which are embedded in concrete at the time of installation. Both these ducts provide a tube sufficiently smooth inside to permit drawing in the cable without excessive danger of injuring its covering.

Before starting the work, all available plans should be consulted to avoid as much as possible, the existing waterpipes, sewer and gas pipes or cable systems of telephone or other electric systems. Test holes are often desirable to learn the character of the under ground and these are usually dug at the manhole location.

When the actual work is started, all the conduit should be piled on the side of the sidewalk at regular intervals. The cement may be stored on the opposite

side on a platform raised several inches off the ground and well protected from the weather. Care must be taken in storing material not to obstruct driveways, or fire hydrants, and careful and courteous consideration given to the complaints of the adjacent property owners.

Guarding the Work

Too much stress cannot be laid on the importance of guarding the work of construction. Proper barricades must guard the openings at all times and sufficient lights should mark all traffic obstructions at night. Watchmen should be employed at night to guard the property and keep the lamps burning as it has often been demonstrated that a single serious accident will cost a great deal more than the best of protection.

Provision should also be made to remove surplus earth as fast as it is removed in order to reduce congestion.

The trench is usually laid out about 5 ft. from the curb and if the district be exceptionally heavy, a duct is laid on both sides of the street. Every effort should be made to keep the duct straight from manhole to manhole and short bends should always be avoided. The distance between manholes should be about 400 ft. and not exceed 500 ft. This length of cable in the larger sizes is usually supplied on a reel. The trench should be dug the entire length between manholes and then carefully graded so that it drains from the center toward the manholes at about 3 in. grade per 100 ft.

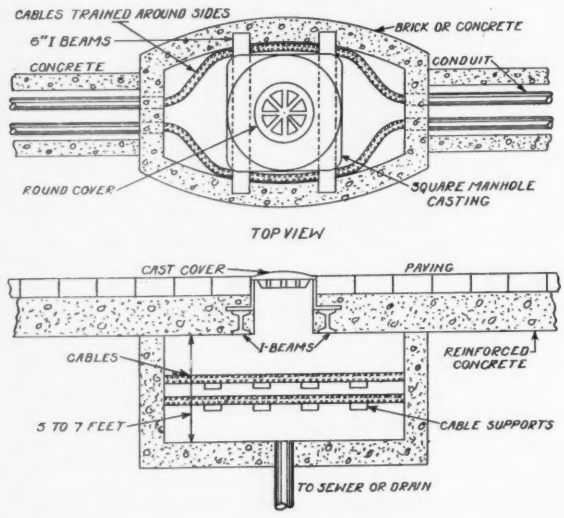


FIG. 5. TOP AND SECTIONAL VIEW OF MANHOLE

The concrete bottom may now be placed and when it is properly set, the first row of conduit may be laid. Clay conduit should have the joints wrapped with burlap to prevent the entrance of concrete, and fiber conduit should be held in position with proper spacers. The lower layer of conduit is now covered with concrete and the second laid and so on until the requisite number is built up. Figure 4 shows the method and a typical installation of fibre conduit.

The conduit should have a full 3-in. wall of concrete all around it to prevent damage from future evacuators.

Refilling is an important item. Only the best of the soil should be used in refilling and three tampers should be used to one shoveler. In case tunnels must be dug under sidewalks, it is often advisable to remove the walk when refilling in order to secure perfect tamping and guard against future accidents. If tamping is not done correctly, the chances are that the paving must be relaid again, thus causing unnecessary expense.

Manholes and Handholes

At street intersections should be located the manholes in which the cable splices are made. The size of manholes is often limited by existing water and sewer pipes, but they must be large enough to enable the workmen to perform their work efficiently. Ordinary service manholes may be only 5 ft. high inside, but junction

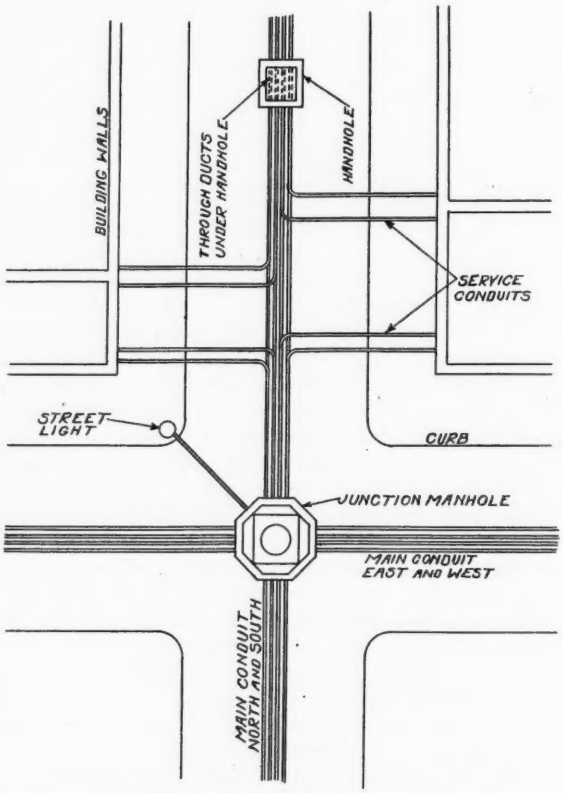


FIG. 6. TYPICAL STREET LAYOUT

manholes should be at least 6 or 7 ft. from roof to floor and provided with proper sewer connections so they cannot fill with water. Manholes are often made sufficiently large to contain the distributing transformers. Typical sizes are 5 by 5 ft. where 8 ducts enter; that is, where two four-duct lines cross; 6 by 6 ft. where there are 12 to 18 ducts; 7 by 7 ft. where there are 20 or more and larger if they contain transformers.

Manholes may be made of concrete if the hole can be dug sufficiently large to place the mold. Sewer brick with an 8-in. wall makes an excellent manhole. The covers are usually of heavy cast-iron strong enough to withstand the heaviest traffic. Single ventilated covers are preferable to the double airtight covers, as they permit the escape of explosive gases, and round covers are

preferable to square, as they cannot drop through the hole and cause damage. A typical section of a manhole is shown in Fig. 5.

Handholes are merely smaller openings made for tapping on service feeders for various buildings. They may be about 3 or 4 ft. square and a few feet deep. In fact, in many installations only the top row of ducts enter the handholes, thus permitting the low tension accessible for service taps while the through high tension lines are not in the way. Figure 6 shows a typical street layout with a junction manhole and service handhole.

Distributing Cables

There are three insulations available for cables: rubber composition, varnished cambric and oiled or impregnated paper. The cables are made in single, duplex and three conductor cable for three-phase work. All the lines of an a.c. system, that is two in a single-phase, or three in a three-phase, should be in the same cable to avoid unnecessary heating. The cables in use are almost invariably lead covered, and, once properly installed, should last many years, even though the lead sheathing be destroyed by electrolysis.

The conductors may be round and spaced as in Fig. 7 or they may be sector shaped as in Fig. 8. The size of a cable is limited by its carrying capacity and insulation. For instance, with a standard 3½-in. duct, the maximum size cable would be 3 in. With this size a 400,000-mil sector cable may be insulated for 6600 v. A 300,000-mil cable will stand 9000 to 13,000 v. Thus the maximum load that one cable will transmit is about 4500 to 6000 kv.a. and if the load is greater, additional cables must be used.

The cables may be tested at two to two and one-half times their normal rating to insure satisfactory service. Practically all transmission cables are insulated with oiled paper and can be used successfully for primary distribution if the joints are well made and sealed against moisture. For the service mains, however, where taps are frequently made, it is customary to use rubber-covered cable as this cannot be injured by moisture entering.

Installing the Cables

After the manholes are built and the duct finished, the cable may be drawn in. The duct is first threaded with short attachable lengths of wood to which a pulling line is attached. The lengths of wood are disjointed as they leave the duct. The pulling cable is securely fastened to the cable, preferably by special cable-grips; it is led over proper grooved pulleys to prevent short bends and pulled in the duct by attaching a source of power such as a team of horses or a portable motor to the pulling line.

In the manholes suitable projections are provided to support the cable and it is trained around the side of the manhole, avoiding all sharp bends and angles. To assist in this, the conduits are often spread before they enter the manhole.

The jointing of cables is an exacting job and should only be done by the most experienced and reliable man available. Statistics show that about 9 per cent of cable trouble starts at a joint, so the importance of this cannot be overemphasized. Cable manufacturers issue complete and comprehensive instructions on the subject of splicing, but in lieu of this some good text book should be consulted.

System Protection

Due to the length of time required and the difficulty in making repairs, the underground system should be exceptionally well fused to sectionalize it accurately in case of difficulty. If trouble originates between two manholes, it should be confined to that one section, and if cables be on both sides of the street, the trouble should be confined to one side. If the system is fed by transformers, both the primary and secondary should be fused and connected to disconnecting boxes so the transformer may easily be replaced in case of a burnout. Feeders for distribution systems are usually fused where they enter the network and not at the station, as the operator on duty can usually disconnect the cable manually by opening the switch in time to avoid serious trouble.

Estimating the Cost

There are three principal forms required in the estimation of the cost of an underground system: (1)

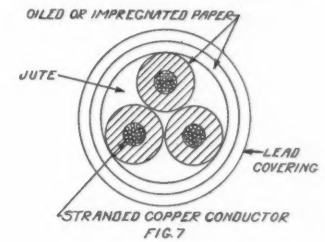


FIG. 7

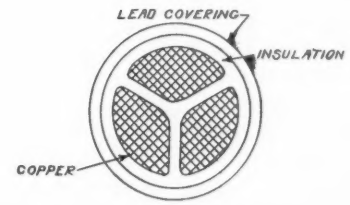


FIG 8

FIG. 7. SECTION THROUGH ROUND CONDUCTOR CABLE
FIG. 8. SECTION THROUGH SECTOR CONDUCTOR CABLE

The estimate of each unit required such as handholes, conduit, concrete, etc. (2) The cost of labor for digging the trench, laying the conduit, pulling in cable, etc. In this must also be included the accident or liability insurance and the cost of new equipment, and depreciation and interest on present equipment. (3) The cost of manholes. Accurate tables are available on these subjects, but in spite of these the engineer must always remember that every little detail from the initial survey to the final splicing and testing costs money and this must be included in the estimate. Unusual and unforeseen troubles must be provided for: bad weather, delay in getting material; forced moving of stores, unsuspected rocks or quicksand, higher rates for Sunday and overtime labor, must be figured in the estimate to keep within the money appropriated for the work.

As the work progresses, however, the engineer can keep accurate cost records not only to check his previous estimate but to form the basis of future estimates.

Safety for Electrical Equipment

SAFEGUARDS FROM FIRE AND INJURY HAZARD. PROPER ENCLOSURES, INSULATION AND GROUNDING. BY W. D. KEEFER*

ELECTRICITY eliminates many hazards where steam or other prime movers are used, but if mishandled or improperly installed, it introduces some new hazards, equally dangerous. The chief dangers of electricity are from shock, burns, "flashed eyes" and fire.

ELECTRIC SHOCK

ELECTRICAL shock results from the passage of current through any portion of the human body. The severity of a shock depends upon several factors. It becomes more severe with an increase in voltage applied; with an increase in area of bodily surface brought into contact with the electrical circuit; or with an increase in the amount of moisture on the contact surfaces. Perspiration on the skin is an example of such moisture.

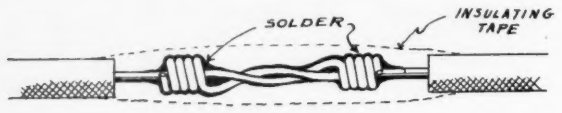


FIG. 1. PROPER METHOD OF JOINING THE ENDS OF CONDUCTORS

On the other hand the severity of a shock is decreased as the resistance of that portion of the body in contact with the electrical circuit is increased. For instance, the callouses on the palm of the hand offer more resistance per unit of area than does the wrist or other more tender portions of the body, and while a shock at the wrist might prove fatal, perhaps on the palm of the hand it would produce only temporary sensation.

The exact quantity of electric current that may pass through the human body without danger to life has not been determined. It is well known that one-tenth of an ampere may be dangerous and that one-fourth of an ampere may prove fatal, although from 7 to 10 amp. are used during the electrocution of criminals. From the accident prevention standpoint at least, the only safe procedure is to "let it alone."

Another factor of great importance is the course of the current through the body. A current passing from finger to finger of one hand, for instance, has usually only a local effect, whereas when passing from one hand to the other the course of the current may lie through some vital organ such as the heart or the central nerve system, and it is therefore more likely to cause serious results. A similar serious result might follow when the path of the current is from the neck to the foot, or from a hand to a foot.

ELECTRICAL BURNS

ELECTRICITY in its passage through a conductor develops a certain amount of heat which exerts a drying effect on nearby articles and may even set them on fire. Current, when passing through the body, may be distributed over a wide path where there is enough fluid to prevent immediate drying. At the point of contact, however, the current may be concentrated in a small area, and here, the body fluids not being present in great quantity, may be dried up so quickly as to cause a local skin or flesh burn. Burns usually accompany all severe shocks and they often result when the shock is comparatively slight.

Burns may also be caused by contact with or mere proximity to an electrical arc. When a current in following its path is compelled to jump an air space, the intervening air, gases, and volatilized particles of the conductors are heated to a state of incandescence and the flame thus produced is known as an electric arc. The heat of an electric arc is the highest temperature obtainable by man. It is always dangerous and every precaution should be taken to prevent its accidental occurrence. Arcs may form at points where the insulation has been weakened or broken down or at loose joints or connections in wires. An arc may also be formed when opening a switch. This operation should not be done hesitatingly but with one strong, rapid motion.

FLASHED EYES

ANOTHER serious hazard of electric arcs is that of injury to the eye, i. e., "flashed" or burned eyes. When welding electrically or doing other work near an electric arc, operators should be required to wear protective goggles with properly colored lenses, and it is well to take the same precaution when opening a switch where a strong arc may be formed.

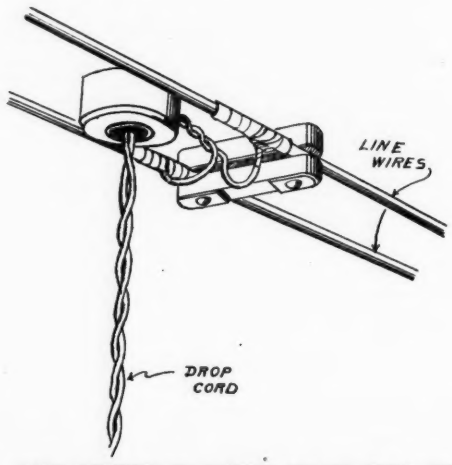


FIG. 2. SAFE METHODS OF TAKING STRAIN FROM JOINT OF FLEXIBLE CONDUCTOR TO LINE WIRES

ABNORMAL CONDITIONS OF CIRCUITS

ABNORMAL conditions, which may lead to injuries, may occur on any electrical circuit, as follows:

(a) Short circuit; (b) Accidental ground; (c) Overload; (d) Poor contact.

Engineers in designing and installing electrical equipment give considerable attention to the avoidance of these four possibilities, but operators should have a

* Safety Engineer, National Safety Council.

complete knowledge of them and should exercise great care to prevent their occurrence.

When an electric current is short-circuited, it does not necessarily mean that the length of line wire has been reduced, but that the resistance of the circuit has been greatly decreased, causing an increase in amperes flow of current, which in turn has resulted in the generation of heat in the circuit. If there are fuses in the line, a short circuit will cause them to "blow" and interrupt the flow of current. This, however, may not afford complete protection, for there is frequently an accompanying electric arc at the point where the short occurs due to the conductor being melted.

An accidental ground is an unintentional connection between an electric circuit and the earth. It may result from a wire coming into contact with a tree, damp pole, gas pipe, water pipe, another wire, or anything metal that is connected with the earth. If there is a ground on the circuit, the person touching it at any point while standing on the ground, or connected therewith through a conductor, completes a circuit to the earth and is liable to suffer injury. Accidental grounds may happen in so many different ways that persons are advised to assume that all circuits are grounded and to insulate their bodies properly when working on any electric circuit.

Each size of conductor has a certain safe current-carrying capacity. If a current above this limit is carried, the conductor may become excessively heated. Fuses and other automatic cut-outs are protection against overloads, but in every case they should be of such a size that they will blow at a point lower than the carrying capacity of the conductor. It is a great temptation when additional illumination is needed to connect more lamps, or lamps of a larger size to wires already installed and then to substitute larger fuses to carry the overload. None of these should be done, however, except by authorized electricians, who must first make sure that the new load will not exceed the safe carrying capacity of the circuits.

If the ends of two good conductors are badly joined together, electrical resistance is increased and the passage of current through the joined conductors will develop heat at the joint. In wiring, poor contacts can largely be avoided by soldering at least five turns (not merely a loop or one wrap) of the wires.

A poor contact is formed when a switch is not completely closed. A switch closed part way may at least be the cause of burned contacts, and it is liable to be the cause of more serious results. These troubles can be avoided to some extent if, in closing a switch, the operation is performed with one strong, rapid motion, thus making sure that the blades are thrown completely into the receptacle or socket of the switch. If the switch is tight or the contact too stiff, the application of a little vaseline on the blades may facilitate the operation.

Preventing Electrical Accidents

In preventing electrical accidents, it is first of all advisable to obtain high-grade equipment that has been approved by Underwriters' Laboratories or some equally qualified authority. Inferior equipment is to be avoided because of the dangers that may develop from defective material or workmanship. Electrical equipment, to be safe and to give the best service, must be properly installed. Qualified electricians should be employed to perform all work of installation.

Considerable danger can be avoided if all utilization equipment is operated at low voltage (under 750 v.). It is difficult to say what voltages are safe, for cases are on record where people have been killed upon coming in contact with a conductor charged with as low as 110 v. Of course, death resulting from shock on low voltages may depend upon the physical condition of the person and also upon the manner in which the shock is received. As a general rule, safety demands the employment of low utilization voltages.

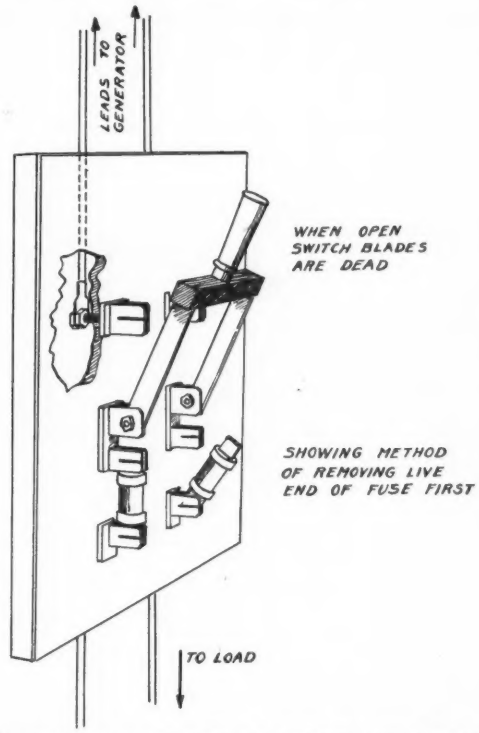


FIG. 3. PROTECTION OF FUSE BY SWITCH AND METHOD OF REMOVING FUSE WHEN NOT PROTECTED

Wherever possible it is recommended that all wiring be placed in conduit and that current-carrying parts of utilization equipment be completely enclosed. If it is impossible or impracticable to place wires in conduit or to enclose current carrying parts, considerable protection can be secured if they are elevated at least 8 ft. above the ordinary working level or platforms that are readily accessible to other than qualified electricians. Even an 8-ft. elevation may not always be sufficient, especially where long rods or pipes are handled.

Another method of isolating special electrical equipment is to install it in specially provided rooms. These rooms, sometimes known as transformer vaults, motor rooms, or control rooms, should be locked and made accessible only to authorized persons.

Where electrical equipment cannot be isolated by any of the above methods, it should, where practicable, be provided with suitable enclosures such as fireproof cabinets, or tile or fiber duct, so arranged as to prevent persons or objects from accidentally coming (or being brought) into contact with live electrical parts. In such

installations, however, provision should be made to permit ready access to authorized persons for cleaning and making adjustments or repairs. Complete enclosures usually provide satisfactory protection, since in addition to other advantages they also prevent short circuits caused by tools, rods, pipes, or other material being handled or used near-by.

If the line has broken down or if the switch is out of order, the electrician should be called upon to make repairs. Even the replacing of burned out incandescent lamps carries an element of hazard if it is attempted while the current is "on"; if it is absolutely necessary for the worker to do this, he should be instructed to shield his face with his arm or hand, or turn it away, while screwing in the lamp. Practices such as lighting

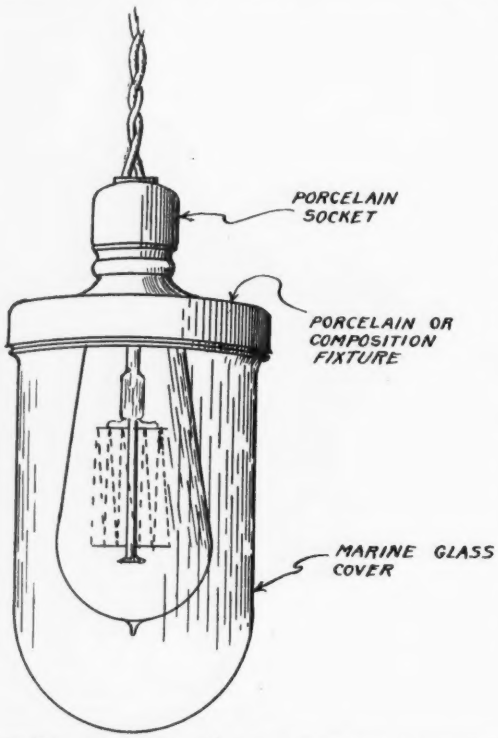


FIG. 4. PROPER EQUIPMENT OF INCANDESCENT LAMP FOR BATTERY ROOM

cigarettes in the arc formed when the contact points of a switch are almost closed are dangerous, the danger being from shock, from burns, or from the flash in the eyes of the worker.

Frequently motors are operated on circuits of a higher voltage than that of the lighting system and this is still more dangerous from the meddlesome worker or amateur electrician. Workers should be prohibited from attempting to repair motors, wires, switches, or any other part of the electrical equipment. Explicit instructions should be given that any and all repairs may be made only by the electrician, and if any repairs are necessary they should immediately be reported to the foreman.

Barrier Guards

When enclosures are not feasible, barrier guards may be used. Frames can be made of wood, rolled metal shapes, angle iron, or pipe. Different types of filler may be used, such as wood strips, sheet metal, perforated metal, expanded metal, wire mesh, or wire glass. The following minimum installation requirements are recommended.

Distance from equipment guarded	Height of guard	Size of openings
Inches		
15 to 20	3 ft. 6 in.	double hand-rail
4 to 15	6 ft.	2 in. square or 1 in. between slats
0 to 4	6 ft.	½ in.

For guarding electrical equipment, wood (if dry and free from oil) has the advantage of being a non-conductor. Wood, however, unless specially protected, is inflammable and may be objectionable on that account. Metal guards are much stronger, last longer and are not inflammable.

Switch boxes and fuse boxes should be kept locked, preferably, but if this is impractical or undesirable for any reason, specific instructions should be given to workers prohibiting them from placing tools or metal parts of metal cans (for example, oil or varnish cans) in the switch box or fuse box, and regular inspections should be made to see that this rule is observed. The danger here is that the metallic articles will cause a short circuit and either injure the employe by the flashover, or damage the equipment. The efforts of ambitious workers to replace a burned-out fuse by means of copper pennies or other metallic substance, copper wire, etc., should be prohibited.

If conditions arise where other methods of protection cannot be employed, the following minimum requirements relative to the working space should be observed: The working space, if exposed to 150 v. or more on one side only, should be at least 2½ ft. wide. If exposed on two sides, it should be at least 4 ft. wide. The working space, if exposed to less than 150 v. on one side only, should be at least 1½ ft. wide; if exposed on two sides, it should be at least 2½ ft. wide.

Identification and Warning Devices

It is a good plan to provide suitable means for identifying all electrical equipment, especially if two or more voltages are used in the same plant. This should include wires, switches, and other equipment and may be accomplished by position, color, number, nameplate, label, or tag. The liberal use of permanent or portable danger signals is strongly advised.

Protective Grounding

Under the following conditions, utilization equipment should have the exposed non-current-carrying metal parts, such as frames of motors, cranes, cars, and switchboards, cases for transformers, oil switches, and wiring permanently grounded:

(a) All operations at voltages of over 150 to ground, wherever equipment is located.

(b) All locations where explosives, inflammable gas, or inflammable flyings (dust, lint, fumes, etc.) normally exist in dangerous quantities.

(c) All parts where exposed surfaces, such as metal frames of other machines, plumbing fixtures, and conducting floors or walls exist within the reach of persons when touching the metal parts under consideration.

(Usually surfaces within 5 ft., horizontally of the parts considered and within 8 ft. vertically of the floor are considered "within reach." Except in cases (b) and (c) of this list, no ground connection need be made to exposed metal frames of switchboards, motors, or lighting fixtures connected to direct-current trolley or third-rail circuits, provided that such frames are effectively insulated from ground, and provided that the metal frames in question are so located with reference to insulating floors or platforms that persons cannot readily touch the metal frames in question without standing on such floors or platforms. Furthermore, parts of machines, such as name-plates, screws in wood, and similar small parts which are not liable to become alive except under very unusual circumstances, may be left ungrounded.)

The ground wire for non-current-carrying parts should be made of copper of a size corresponding to the capacity of the nearest fuse or other automatic cut-out, and as indicated in the following table:

Capacity of Nearest Automatic Cut-Out—Amperes	Size of Ground Wire B. & S. Gage
100	No. 10
101 to 200	No. 6
201 to 500	No. 4
501 and above	No. 2

A No. 14 ground wire may be used for portable equipment that is protected by fuses whose capacity is not greater than 15 amp.

Ground conductors should be run separately to the ground (or to a sufficiently heavy grounding bus or system ground cable which is well connected to ground at more than one place), from equipment and circuits of each of the following classes:

(a) Lightning arresters.

(b) Secondaries connected to low voltage lighting or power circuits.

(c) Secondaries of current and potential transformers and cases of instruments on these secondaries.

(d) Frames of direct-current railway equipment and of equipment operating in excess of 750 v.

(e) Frames of utilization equipment or wire runways other than covered by item (d).

Lightning arrester ground connections should not be made to the same artificial ground as circuits or equipment, but should be spaced where practicable at least 20 ft. from other artificial grounds.

Rubber Mats and Wood Flooring

Rubber mats should be placed in front of switchboards, switches, and other locations where it is possible for operators to make dangerous contact or ground with any conductor or grounded object. Dry wood makes a good insulating flooring, but if nails or bolts project through both sides of the wooden boards, they are liable to become conductors and may destroy the effectiveness of the floor as an insulator. Glass knobs under wood slat sections make good insulators. In some installations, battleship linoleum with beveled edges is glued to the floor with heavy fish glue and then coated with several applications of shellac. Care should be exercised in installing any device to see that it does not form a tripping hazard.

Protective devices should be supplied and placed in conspicuous and suitable places. These should consist of such things as rubber gloves, sleeves, boots, insulating shields, mats, covers, tools, platforms, insulating rods and tongs, portable danger signs and fire extinguishers, which should be labelled whether they are designed for safe use on live electrical parts. Rubber devices, especially rubber gloves, are liable to deteriorate rapidly and should be regularly inspected and tested to determine their real effectiveness as insulators.

Utilization Equipment—Transformers

When alternating current is supplied, it is usually of such a high voltage that it cannot be employed for direct utilization purposes. It must first be stepped down to a lower commercial voltage. The high voltage wires leading to the transformers should be well secured, guarded, and isolated to protect workmen who are not familiar with such hazards and who often think that the insulation on electric wires is sufficient protection. Transformers should preferably be kept outside of buildings and surrounded by an enclosure of wood or grounded metal at least 8 ft. high. If inside of a building, transformers should be placed in a well ventilated fireproof vault, protected by a standard fire door. A raised sill across the doorway will prevent oil from flowing out. In some installations, it might be desirable to construct a drain which will lead the oil from the vault floor to a place where, if burning, it can do no further damage. The door to the transformer enclosure or vault should always be securely locked so that no one can go inside unless absolutely necessary and then only when accompanied by an electrician.

Electrical Fires

All workers should be warned not to attempt to put out an electrical fire by the use of water or soda acid extinguishers or any type of extinguisher which includes water. The water is an electrical conductor and may be the means of a serious electrical shock. All such fire extinguishers should be removed from the vicinity of electrical apparatus if practicable and replaced by extinguishers of the carbon tetrachloride type. Various types of dry powder extinguishers and dry sand may also be used to extinguish electrical fires.

Portable Wires

Wires, to be portable and flexible, cannot be placed in conduit and are therefore usually more subject to deterioration and injury than fixed wires. All flexible cord should be as short as possible. It should be given regular and careful inspection, and where practicable it should be so located as not to be within reach of plumbing fixtures, concrete floors, and other objects that are well grounded. If the cord is much bent or kinked, there is great possibility that some of the wire strands are broken and may pierce the insulating covering and cause a shock to the user. To prevent the electrical connection from bearing all the mechanical strain of the weight of a pendant or the pull of a portable device, the flexible cord should be attached to a knob or a cleat very close to the point where it is connected with the main circuit. The use of rosettes or receptacles accomplishes the same purpose.

Automatic Cut-outs

Automatic cut-outs are installed primarily for the protection of electrical apparatus. In addition to this,

however, they give protection to persons in exactly the same way. Circuit breakers operate more quickly than fuses, but are usually confined to switchboard installations and should, therefore, not be operated by anyone other than authorized electricians. If the equipment is accessible to other employes as well, it may be advisable to guard or isolate the handles or levers of circuit-breakers and similar parts which may move suddenly and are liable to injure persons standing nearby.

It is desirable wherever practicable to have fuses protected by a switch, which upon being opened will make dead the fuse to be handled. This reduces the danger encountered when replacing fuses. Furthermore, fuses should never be handled until the switch has been pulled. Insulated fuse pullers should be used instead of pulling or replacing by hand. If the fuse is not protected with a switch, the live end of the fuse should be pulled out first; when replacing the fuses, the live end should be put in last. When fuses blow, they should be replaced by fuses of the same type and size.

Switches

Probably the most common is the open knife switch, especially adapted for controlling individual motors on machine tools, and for lighting and power circuits. It should not, however, be used to break a circuit carrying more than 750 volts. An open knife switch may be hazardous even on voltages lower than 750 because of the arc which it sometimes draws and because when not enclosed it admits of accidental contact with live parts. The latter danger is removed by enclosing knife switches in properly insulated metal boxes. The operating lever may extend through a slot in the cover.

Knife switches, whenever possible should be mounted so that the blades are dead when the switch is open, single throw switches being so installed that gravity will not tend to close them, as shown in Fig. 3.

Oil switches have the live parts operating in oil and thus eliminate many dangers in controlling circuits of more than 750 v.

Push-button and snap switches usually have all live parts enclosed. The former should be installed in a metal box and the latter mounted on a porcelain subbase. Switches of this type should indicate whether the circuit is open or closed. Neither of these switches, however, should be used to control a circuit of more than 30 amp. or over 250 v.

It is not advisable to install a key socket if a push-button or snap switch can be made to serve in its stead. If a key socket must be used, one made of porcelain is safer than one made of brass. The pendant switch is used principally where switches on side walls have not been installed and where it would be difficult or expensive to put them in, or else where the switches on side walls or in cabinets control two or more circuits and it is desired to subdivide them still further so that each can be controlled individually. This device is merely a special type of push-button switch suspended from the ceiling by a flexible cord.

Starting Rheostats

If starting rheostats have exposed live parts, they should be enclosed. This can be accomplished by making a box-like arrangement with a slot through which the operating handle extends. Sometimes starting rheostats and switches have removable handles. If the switch is guarded, the handle may be unscrewed and removed by any workman who wants to make sure that it will not be operated while he is working on the circuit or equipment which it controls. When he has finished his work he can replace the handle. Another arrangement provides a cover over the rheostat and handle, which can be locked and the key removed by the workman who is engaged on the circuit.

Storage Batteries

Storage batteries exceeding 150 v. or a capacity of 15 kw.-hr. at an 8-hr. rate of discharge, should be made inaccessible to other than properly qualified persons by being placed in a separate room or enclosure. Provision should also be made for proper ventilation to remove acid fumes and inflammable gases that may be generated by the batteries. The batteries should be supported by suitable insulators, and there should be suitable drainage to prevent the accumulation of water or liquid that may leak from the cells. Acid-resistive floors, such as vitrified brick, or concrete treated with a solution of silicate of soda, are recommended where large batteries are installed. Storage battery rooms should, if practicable, be lighted from lamps outside of the room. Open flames are dangerous because of the inflammable gases that may be generated by the batteries. If lights are located inside, only incandescent lamps should be used. Incandescent lamps for this purpose should be held in weather-proof porcelain or composition sockets, all enclosed in moisture-proof globes. Control switches for these lights must not be exposed to battery vapors. Conductors about batteries, if of such material or so located as to be liable to corrosion, should have coatings of lead or other suitable protective coverings.

New Plant at Amsterdam, N. Y.

Work is actively progressing on the new steam power plant of the Adirondack Power and Light Corporation at Amsterdam, N. Y. This plant, located about three miles east of Amsterdam on the south bank of the Mohawk river will tie in with the company's present system. The initial installation will consist of a 15,000-kw. turbine with boilers; the building being built large enough for two such units, however. The boilers will be built for a working pressure of 300 lb. and the steam will be superheated 200 deg.

A complete description of this plant together with a list of all equipment installed will be published in these columns in the near future.

U. S. Civil Service Commission announces an examination for aid, receipt of applications to close Aug. 30, to fill a vacancy in the lighthouse service, Third District, Tompkinsville, N. Y., at $1500 a year, plus increase granted by Congress of $20 a month, and vacancies in positions requiring similar qualifications, at this or higher or lower entrance salaries. It is the intention of the bureau to make appointment to this position with a view to training appointees to fill the position of assistant superintendent by promotion, when vacancies in this position occur, at base salaries ranging from $1800 to $2520 plus the bonus authorized by Congress. Apply for Form 1312, stating examination title (Aid—Lighthouse Service).

Influence of General Design on Efficiency

GENERAL DESIGN, ARRANGEMENT OF UNITS, AND CLASS OF EQUIPMENT ARE FACTORS THAT HAVE AN IMPORTANT BEARING ON THE OVERALL EFFICIENCY OF A HOTEL POWER PLANT. BY GEORGE TALCOTT INGERSOLL

THE AUTOMOBILE is a power plant. It is said that the design and arrangement of the automobile was worked out about 15 yr. ago by one man, and with no material change from the original design the demand has exceeded one million per year. With the close competition in the business for all these years it would seem that this power plant is designed for utility, simplicity and efficiency. How many hotel power plants are so designed?

The architect who furnishes the plans and specifications for a large building may, under the pressure and competition of modern business, find it necessary to make the biggest showing possible in outside finish for the money to be expended. In the case of a large hotel, he may, for this reason, modify and adapt plans previously used to suit the present occasion. If he finds that his cost is running higher than his estimate, he must cut down somewhere and too frequently the power plant is chosen as the goat. Certain rooms and an estimated amount of space are allotted for the machinery, and into this space that machinery must go often regardless of utility, simplicity and efficiency in operation and upkeep.

The contractor may work under similar conditions. He is concerned in getting the job completed and accepted, at a profit to himself, otherwise he could not stay in business.

So we find too often bad design and faulty arrangement of power plant which occasions a loss and unnecessary expense every year the plant is run. This subject is important and well worth attention in many hotel plants.

As nearly every machine in the power plant is connected with some other part of the equipment, the class and kind of connection and the arrangement of piping and fittings is important. The waste and loss due to bad flow lines in pipes is much greater than is generally supposed.

This applies to liquids and gases. All pipe should be reamed inside at the end. It pays to use long radius bends with flanged couplings having ground metal joint, and avoid 90 deg. ells and tees. The writer has seen hotel power plants where the bad design and arrangement of piping caused a loss in operating of several thousand dollars per year.

It is much cheaper to make changes on paper and work out the best than it is to use a bad design and pay a fixed charge year after year on account of low efficiency in operation.

Closely allied with the general design and arrangement is the ventilating equipment, the air cleaning and humidity regulation. The majority of people think they must have three meals a day, though hundreds of persons have fasted from 40 to 60 days with benefit; but no man or animal can live long without air. It would seem that the quality of the air in a hotel therefore is quite important and closer attention should be given to this part of the equipment.

The general design and arrangement of a hotel power plant is to me an important guide or index to the efficiency of the plant as a whole.

CLASS OF EQUIPMENT

THERE ARE many different classes or grades of watches, just as there are many different classes or grades of hotels, but we are considering high class watches and hotels, and in such hotels we expect to find high class efficiency equipment, just as we would expect to find a high grade movement in a high grade watch.

It is said that our great industrial progress in the past few years has been in a large measure due to quantity production of standard machines. The automobile is a good illustration and a similar program is used in the manufacture of many different kinds of machines, some of which are used in hotel power plants. This type of machine serves a necessary and useful purpose, but it does not follow that it is the best type to use in the power plant of a large modern hotel.

Take a motor-driven centrifugal pump such as is used in large hotels for house service. Compare two types, one a stock pump, the other of special design. One will be designed to cover a wide range of conditions, made by quantity production of material and workmanship to sell at a certain price; the efficiency will be fair. The other will be of special design to suit the conditions under which it is to work and will have highest class material and workmanship and will operate with high efficiency. Set the two pumps, each mounted on base for motor drive, side by side. Each is neatly finished and painted; each will pump the quantity of water required. To the average power plant man, they look very much alike. How is he going to tell which is the better pump? The natural and easy thing to do is to buy the cheaper pump and think it is a good bargain.

Some figures, however, made as to operating costs over a period of 5 yr. under conditions which we are considering will show that the high grade special pump will operate at $500 to $600 per year less than the stock pump. Admitting that the special pump was higher to the amount of $500 in first cost, which is the cheaper pump to buy for the large modern hotel? Water under pressure is so vital to the hotel that much more might be said on the subject of pumps, but the point is that the modern hotel is a high class business investment.

We do not find some of the guest rooms with polished brass or hardwood bedsteads or rugs of the finest material, leather chairs, white porcelain bathtubs, and other guest rooms with cheap iron bedsteads, kitchen chairs and zinc bathtubs. On the contrary, the guest room furnishings and equipment are uniform and in keeping with the high class of the hotel. May we not therefore rightfully expect the same rule to be applied in the power plant equipment?

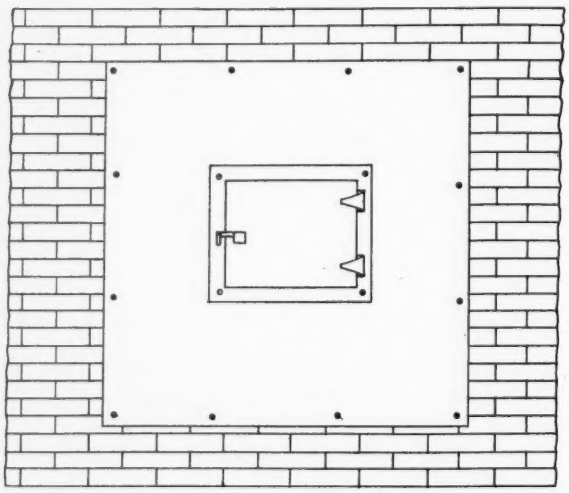
The class of equipment whether it be uniformly high class throughout, or some of it cheap and inferior, therefore, gives an interesting and valuable guide to the overall efficiency of the power plant.

BETWEEN a constant grouch and the smallpox, give me the smallpox.

Sheet Iron Protection in Boiler Rooms

FURNACE fire doors serve several useful purposes. They permit access to the furnace to allow fires to be cleaned and their condition noted; they allow tubes to be inspected to determine whether sufficient slag has adhered to them to warrant removing it and material to be taken in and out of the furnace during repairs.

The cleaning of fires in many cases means rough handling of clinker masses with the slice bar. With inferior coal and heavy loads, frequent cleaning is often necessary and the work is done hastily because of the need to keep up steaming rates, because of the intense heat and the physical exertion required. The result is that getting the job done quickly is given more attention than doing it carefully. The brickwork around the furnace side doors suffers.



PROTECTION FOR BRICKWORK AROUND DOOR

It is not uncommon to find that a setting well painted to prevent air infiltration is badly cracked and pieces of brick broken off around the frame of the side doors. Dents from the slice bar (especially where the space between furnaces is cramped) knock out chunks of brick and in other ways allow air infiltration to occur. This condition can once and for all be overcome in a simple manner as shown in the accompanying illustration.

The protection consists of a sheet-iron plate installed around the side door frame so that for a distance of 10 in. to 2 ft. no brickwork is exposed. Preferably this sheet should be in one piece, and should be installed before the side door frames are installed so that the frames may be used to assist in holding the sheeting in place and at the same time make an air-tight job. The outer edges of the sheeting are held closely to the brickwork by bolts and expansion wedges.

One Middle West utility operating about 40 boilers with underfeed stokers has been able to eliminate the rapid deterioration of the brickwork around the side doors in the foregoing way, and also stop the air infiltration that accompanied it.

Another use for sheet iron is for pipe coverings. Steam pipes passing above side doors or above boiler room entrances and similar exposed places are often subject to damage to their asbestos or magnesia pipe coverings by crane hooks, materials falling against them and so on. The canvas protective covering for the heat-insulating material is not able to withstand rough usage and so, before long, the pipe covering is knocked off. Not infrequently, pipe coverings are omitted entirely in exposed places.

It is a good policy in cases of this kind to protect the pipe coverings with a sheet of iron, or several sheets of iron, depending upon the length of the exposure. This sheeting is wrapped outside the canvas covering, tightened up with wire and soldered in place or strapped by metal strips. In this way, rough contact with materials or objects in movement does not injure the covering of heat-insulating material, and its life will be as long as that in protected locations.

Water does not injure pipe covering although it does reduce its insulating properties and tends to rot the canvas. Oil is, however, injurious. Where water and oil drips and steam may come in contact with the pipe coverings, it is also well to employ a sheet iron wrap. To do so costs little and is well worth while.

R. K. LONG.

Cutting in Boilers

I HAVE READ with considerable interest the article in the May 15 issue by Mr. Wakeman, and comments on it in the June 15 issue, page 632, by W. L. N., Raymond J. Roe and I. F. Richmond. I have never tried cutting in a boiler when there was over 10 lb. difference in line and boiler pressure, if I knew it, but I have seen it done and nothing happened; however, I do not consider it good practice, as I should be afraid of water in a boiler or boilers, on the line, having greater pressure, syphoning over into the one having lower pressure, drawing my conclusions from the following experiences.

Some years ago when I was assistant in a plant, the company had a smoke consuming device installed in one of the furnaces, which will be designated as No. 1. The installer of the device wanted the total load on No. 1, so he was accommodated and everything went O. K. until the day's peak load came on at 3 p. m. when he could not hold the pressure. Number 2 had been banked and held in readiness for such an event and was cut in in time to save the day. At night, the chief told me to

let the fire go out in No. 1, but leave it on the line so it would be hot in the morning, letting the smoke consumer gang clean and start their own fire. So far so good.

Fire was kept under No. 2 all night and everything lovely except that the night man had to blow down No. 1 three or four times during the night. At 6:45 the next morning, I blew the starting whistle and right away the water in No. 2 started going over into No. 1. They were connected by one 6-in. header and one 3-in. header, which meant two valves to close to cut out a boiler, and I cut her out; but talk about noise! And there was no water in sight in glass of No. 2 and No. 1 was full to the top, also everything else. I could get water at bottom gage glass cock on No. 2, so started pump and everything went off O. K.

About two weeks afterwards, a 6-in. cast-iron extra heavy elbow on the header developed a leak and when covering was removed, showed a crack about 2½ in. long. The other instance was the result of a mistake in understanding orders given to a subordinate. A boiler in a battery had been cut out and fire drawn to cool down for washing out. The man was told to blow down the boiler until water was ½ in. high in the glass and then to run in some cold water until it was up to the second gage cock and let it stand. He became confused somehow and went up on top of the boiler, loosened the bolts on manhole crabs, hooked the block and tackle to the manhole plate, took the bolts and crabs off and punched the plate in with 4 by 4-in. timber. There was some pressure on the boiler, just how much I don't know; but when the plate went in, the water came out and Mr. Man got one of the hottest baths of his life.

Now, other fellows can "take a chance" if they wish, but after these two experiences I am strictly in favor of Safety First, although it may take a little longer.

Some time ago a friend of mine tried a stunt in his plant which, if a place could be equipped to handle the idea, would be quite a fuel saver. Others may have heard of it, but it was a new one on me and I never saw anything in print like it. His idea was to cut a hole in the breeching, connect a fan and draw the hot gases from the breeching and pass them under a boiler that had been washed out and ready to fire up again. He got the boiler hot all right before fire was started on the grates, but the fan he had would melt out the bearings handling the hot gas. He did not attempt to burn the gas, just simply passed it through the boiler and back to the breeching.

FRED S. RUTLEDGE.

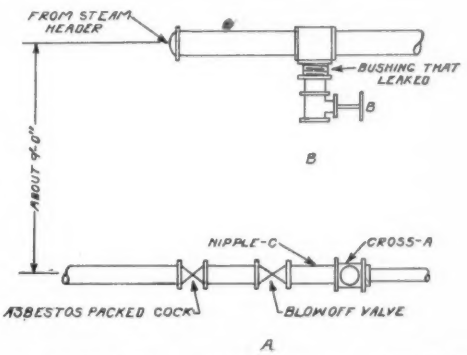
It's the Little Leaks that Count

TO SHOW what a little leak in a steam or water pipe and its connection is able to do in the course of time, I relate the following:

The blowoff pipe comes through one of the side walls of the boiler setting and is arranged as shown in Fig. 1 at A. The pipe is equipped with a regulator; Y, blowoff valve next to the cross A. Next to the valve an asbestos packed cock is located which is only closed should the regulator valve leak. About 9 ft. above this blowoff pipe, a 2½-in. steam line is located as shown in Fig. 1 at B, furnishing steam into the factory for heating and manufacturing purposes. In this steam line was a tee where the middle opening was reduced from 2½ to 1¼ in. with a nipple and valve next to the tee. This branch furnished steam to an injector. For some reason, the injector was disconnected from the line, as was also the pipe up to the valve B. In disconnecting the pipe from the valve, the bushing sprung a leak, which was not repaired, and the water of condensation kept on dropping onto the nipple C between the cross and blowoff valve until this had rusted away at the point where the water came in contact with it to such an extent that the boiler inspector noticed it and while examining he drove a hammer clear through it. Had these conditions not been noticed by the inspector, it is hard telling what would have occurred in a short time.

That was a case of carelessness; the leak, of course, was not bad and no escaping of steam was heard in the boiler room, hence I suppose the engineer did not give the matter any attention until the little leak nearly caused a shutdown of the plant, perhaps injuring someone by scalding if the nipple had let go unexpectedly.

The nipple was renewed at once, and the leak in the steam line was repaired by removing the bushing and placing a plug in its place.



RELATIVE LOCATION OF STEAM LINE AND BLOWOFF LINE

No doubt there are many more steam plants where there are little leaks, but no attention is given them, though during the meantime they are perhaps ruining some apparatus unknown to the engineer. To be on the safe side, any little leak should be repaired at the first opportunity to avoid trouble and eliminate waste.

H. A. JAHNKE.

College Education and Practice

I HAVE read with interest J. B. Ficklen's article entitled "College Education and Practice," published in the July 1 issue, and I believe that his view on this subject is a bit distorted. Inasmuch as a man spends 4 yr. of his life and considerable money on a college education, it seems to me that he should get the things in college that it is impossible to get outside. Why spend good time and money on getting mediocre practical experience in college while one can get any amount of such experience and better "out on the job"?

Mr. Ficklen asks, "How can a college man go forth and give the order to brace this joist, etc., if he has not had the practical side of it in college?" How many contractors hire a man fresh from college to run a job? Ninety per cent of the men just out of college usually take subordinate positions where they are not expected to give orders, but where they gain more practical experience in six months than they could gain in four years of the most practical and "shop-hewn" of college courses.

I believe an engineering course should be well sprinkled with economics, business law, business principles and practice and courses which will be of great value to the man 5 or 10 yr. after he has graduated from college rather than specialize on practical shop work, which is beneficial during the first six months after graduation but becomes of small value a year after the man has left college.

Too many of our engineers are strictly technical and lack the broader viewpoint which is highly essential to any sort of real success. I am strong for a broad, general engineering education and have little use for the shop course; there are too many trade-schools which compare very favorably with the latter type of course.

Some of our colleges and universities are awakening to this need, namely a broad and general engineering course.

G. S. BRADFORD.

Firing Boiler Furnaces

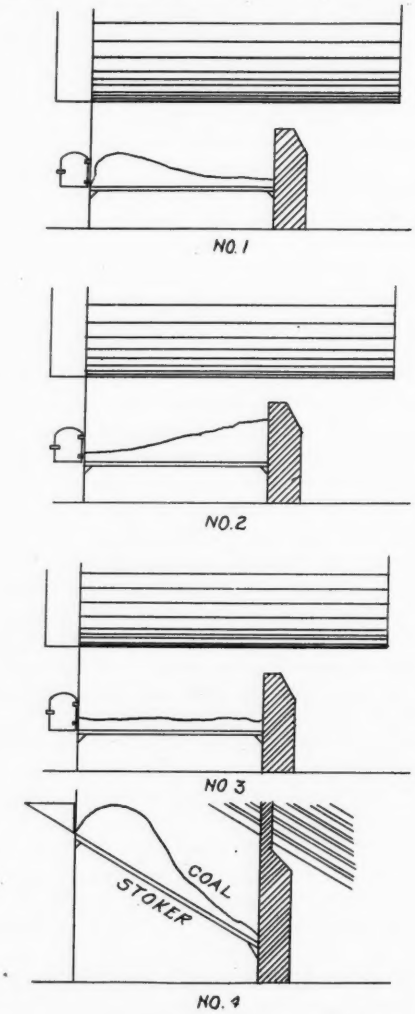
WHEN one travels around and sees firemen in different plants using different methods to make the most steam, he finds out what kind of a fire will keep the damper closed. One man will tell you that a fire level all over, No. 3 will do the best; another will carry it thin in front, inclining upward to bridge wall, No. 2, and another uses the coking method high in front and tapering down to bridge wall, pushing the front back instead of putting fresh coal on back, No. 1.

The real test for each method is when boilers are working above rating, because any old way will keep the damper closed with half a load. I have seen and tried enough of all of these methods in the past 25 yr. to convince me that if method No. 1 is used when the maximum amount of steam is needed, it has been the safest way of insuring plenty of steam, at least 12 in. high in front, inclining downward to about 4 to 6 in. at the bridgewall and seldom putting on any new coal at the back of the grate for 3 ft. in front of the bridgewall, but pushing that which has been coking at the front back and after a short interval firing up in front for coking again.

I have never seen a better method used than this, both for making steam and burning smoke, because the fire near the bridge wall is kept bright all the time which burns the gas off the coking pile on the front of the grate. This principle is followed in most mechanical stokers whose grates incline downward as in No. 4. The coal is piled high in front and tapers to quite thin at the bridgewall and it needs no statement here as to the steam-making qualities or smoke consuming features of this method.

Another proof of the efficiency of this method came in my own experience while using forced draft. Those who have used a fan system of forced draft have found out that the fan will tell the fireman when he is firing right or wrong because if you are doing right the fan will not have to make up for your bad firing, hence it will stop when the damper closes, if so connected. In this case, I had a new fireman and I noticed that the forced draft fan would keep running about all day so I looked at the fire and found that he was carrying his fires light in front and high behind as in No. 2. I told him to reverse this method and to pile eight shovelfuls in front and only four shovelfuls in back. This kept the back low and bright, and in a short time the forced draft would stop because it was not needed, as the damper would close, thus showing that a better method was being used and more steam being made. He admitted frankly that high in front and low behind did the trick, giving us all a great relief from the continued howling of the forced draft fan.

In this case, as in all other cases, a draft gage is a good thing when attached over the fire, and if watched occasionally will tell the fireman when air holes occur in the fuel bed quicker than the steam gage because a slight hole in the fire will show less draft on the gage.



FUEL BED IN DIFFERENT FIRING METHODS

I have seen the steam drop numerous times when the cause was due entirely to a high fire behind and mostly of unburnt coal practically banked behind, but bright in front.

If No. 3 method is used, I find a great tendency gradually to build it up behind because not so much is consumed on the back half of the grate even with 1½ in. of forced draft; there is nothing better than the fan to tell you this.

I have used the foregoing methods while burning as high as eight parts of anthracite screenings mixed with only one part of bituminous coal. This fuel, of

course, had to be thoroughly mixed and well spread over the fire light and often, while straight soft coal can be fired heavier, but with all kinds of fuel, I find this method, together with a little horse sense, is successful when other ways fail.

In another instance a fireman came to me and said, "I guess I have lost the steam, as it is going down all the time."

In looking into the fire I found it low in front and high behind. I simply raked the back to the front, making it high in front and low behind, and did not put any new coal on. At once the steam started upward and soon closed the damper. After some time the fireman came to me, saying, "Well, I guess I might as well go home."

"What's up?" I inquired.

"Well," said he, "there is nothing to do as I haven't touched that fire since you did."

It was this high back fire that was mostly unburnt and would not let the draft pull through it. This kind of a fire will pull pressure down quicker than clinkers on the grate.

A. C. WALDRON.

Safeguard Against Pressure on Suction End of Pump

IN THE modern power station using centrifugal boiler feed pumps, there is a feature in the design of some makes of pumps that is overlooked. This feature is that the suction or low pressure end is not made to withstand the pressures that are pumped against it by the higher stages.

During the regular operation of the pump, this is of no consequence; but when the pump is shut down and the valve in the suction line closed, if dependence is placed in the discharge check valve, and it should leak, the pressure from the feed line will accumulate throughout the pump, subjecting the lightly constructed suction end to the full feed line pressure. A safeguard against this is, of course, a small water relief valve set a little higher than the suction pressure—this valve to be placed between the pump and the valve in the suction line.

JOHN F. HURST.

Watering Coal

HAVING READ the able article on this subject, on page 714 of the July 15 issue, and noting its well balanced theory, it appears as if the subject might be profitably continued by submitting a chapter on the practical side of the question.

Having received a lot of coal that was very dry, I proceeded to make two tests, the sole object of which was to determine the comparative value as far as the actual evaporation of water is concerned, of dry and wet coal. These tests were conducted under the same conditions otherwise as the coal was from the same lot, and the rate of combustion as nearly alike as convenient. A forced draft of about one-half inch of water was maintained under the grates by an Argand blower.

TEST NO. 1. DRY COAL

Duration of test	10 hr.
Pea and dust	4181 lb.
Soft coal	1000 lb.
Total	5181 lb.
Proportion of mixture	4.18 to 1
Coal per square foot per hour	17.3 lb.
Power developed	134.4 lb.
Water evaporated	43,020 lb.
Water evaporated per pound of coal	8.3 lb.

TEST NO. 2

Stated weight is of dry coal. It was then wet down with all of the water that it would absorb.

Duration of test	10 hr.
Pea and dust	3666 lb.
Soft coal	780 lb.
Total	4446 lb.
Less 3 per cent moisture	133 lb.
Net weight	4313 lb.
Proportion of mixture	4.7 to 1
Coal per square foot per hour	14.4 lb.
Power developed	121.5 hp.
Water evaporated	38,880 lb.
Water evaporated per pound of coal	9 lb.
Increased evaporation due to wet coal	9%

W. H. WAKEMAN.

Regarding Telegraphy

THE WORD "telegram" is so well understood by most of us who use the telegraph from time to time, that even to mention the word conveys the impression that the message was sent by wire. Few, however, know how such epistles came by the name.

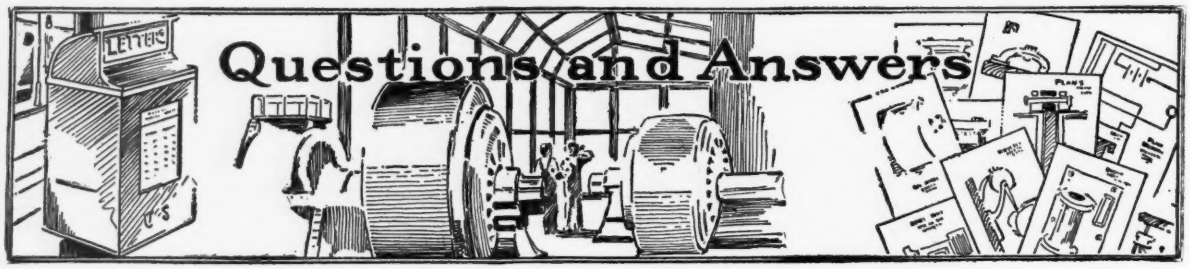
When that avenue of communication was first opened up to the public, it was customary for each person to style it in his own phraseology; for example, "I received a message." "I sent a dispatch." "Did you receive a telegraph message?" and so on. In 1850, however, it is related that Judge Brown, of Ogdenburg, N. Y., who used the new system quite frequently, concluded that it was good enough to have a name of its own, so he gave the world the word "telegram," and because it was an excellent coinage it has lasted.

Another question that may be of interest is, how long would it take a telegram to go around the world? Of course the answer is largely problematical, but in a test made several years ago, a telegram that started from New York, went across the Atlantic, Pacific and the land between them, made the entire circuit in 12 min.

Several years since, feeling that "wireless telegraphy" was a rather long-drawn-out way to express that art, I suggested that the newcomer be known as "ethergraphy"; but for some reason, best known to the rest of the world, it was not received with favor. At least I have never heard that it was.

J. B. DILLON.

AS A means of preventing future famines in certain poorly watered districts of northern China, the American Red Cross, as part of its famine relief work, is aiding the farmers in the construction of wells with which to irrigate their land. Particularly in the hill districts they have relied chiefly on rainfall. No adequate scheme of ditch irrigation can be devised, as the entire water supply lies at the same level as the water in the wells. It is expected that each well will irrigate about 3½ acres.



What Are Your Answers?

WHAT RELATION should there be between the heating surface of a boiler and the combustion rate of coal?

2. What effect has the angle on the strength of a crowfoot brace?

3. What is the relation between the weight of air and that of steam?

4. Why is the butt end strap on a connecting rod made heavier?

5. In any type of cross-compound engine, should the low-pressure cylinder have the same mean effective pressure as the high-pressure cylinder? READER.

Scored Pump Cylinders

I HAVE CHARGE of several single cylinder double acting steam pumps, 10-in. diameter water cylinder by 12-in. stroke. These pumps are at present fitted with two-piece water pistons, using hydraulic spiral packing.

I am experiencing a great deal of trouble because the sleeves of the pumps are scoring very badly. They are used for boiler feed service, pumping at 30 strokes per minute against a boiler pressure of 100 lb. per sq. in., temperature of boiler feed water 200 deg. The pumps have been in service 3 yr., running continuously. New brass lining sleeves were fitted to these pumps a year ago and are at present badly cut. I have tried various makes of high grade hydraulic fibrous packing, have exercised the greatest care in packing the pumps and renew the packing at intervals of one month. The suction water to the pumps is apparently clean and free from scale, but the liners seem to score in spite of all precaution.

I am thinking of equipping these pumps with solid metal pistons and snap metal packing rings. Would it be practical to fit the pumps with new brass sleeves and use solid cast-iron pistons with cast-iron snap packing rings? Would the weight of this piston be excessive and cause excessive wear. If any of the readers have had similar pump difficulties, their opinions would be appreciated. E. G. M.

Examination Questions

WHAT IS the best method to start a direct connected, condensing compound engine?

2. How would you make a shop inspection of a Pennsylvania standard boiler?

3. How would you make a shop inspection of a standard type boiler under Michigan rulings?

4. Why is it that the state of Michigan does not approve of externally fired boilers of greater diameter than 84 in.? C. E. R.

Heating System

REPLYING to E. F. J., whose question appears on page 735 of the July 15 issue of Power Plant Engineering, I think the 54-in. by 14-ft. boiler is of sufficient size to supply heat for the 8000 sq. ft. of radiating surface mentioned with a vacuum system, preferably a vacuum return pump. I fail to see where there is any advantage in using a dry vacuum pump as he states. I never heard of one being used on a heating system. The steam pressure could be raised up to the setting of the safety valve, 75 lb., and using a running pressure of 65 or 68 lb. on the boiler will give a higher temperature to the steam leaving the boiler than would be obtainable with 1 to 2 lb. pressure. This higher pressure will run the vacuum and boiler feed pumps as well as furnishing pressure for handling the fuel oil. But one inconvenience is experienced in some cases when atomizing the oil with a steam jet, the condensate carried with the steam affects the flame at times, though not to such a degree as to prevent successful operation. Hence air is used where possible for atomizing.

The boiler is a trifle small to evaporate the large volume of water required at 1 to 3 lb. pressure, because the difference in the temperatures requires a larger volume to be evaporated to carry the required heat through the building at the lower temperature on pressure. By using a vacuum pump, which will be of small size for 8000 sq. ft. radiation, and a feed pump with an open heater of some water storage capacity, the exhaust steam from the pumps can be used to heat the feed water entering the boiler. The pumps would probably require from 4 to 8 hp. for all of them. Then the heater is placed below the level of the returns so the returns can flow to the heater by gravity if desired to shut down the vacuum pump, and the float overflow valve will make the heater serve as a receiver tank and a trap when the feed or vacuum pump is not running. This makes a very economical plant to operate.

The reducing valves would permit of any pressure desirable being used on either section of the system and by having a stop valve in the return pipe from each section where it connects with the suction pipe of the vacuum pump or heater, the valve could be throttled to prevent annoyance from the higher pressure line destroying the vacuum or raising the pressure on the other line. The first cost of the installation is much more than a system using traps and return traps, but the gain in economy and convenience of operation is more than enough to offset this; it will pay the difference, in this case, in one season.

The return trap is more expensive to operate than a pump because it has to be filled with live steam to the full volume of the trap to equalize the pressure in the

trap with the pressure in the boiler in order for the water to be forced into the boiler. This volume of steam must be condensed or exhausted from the trap each time it empties or it will not fill again, and this exhaust steam is equal in cubical volume to the volume of the water and even more if any make-up water is used, because the difference in temperature of the water entering the trap and the steam will condense some of the steam entering the trap to force the water out. Then with a feed pump it can be regulated at any desired speed to keep up the water in the boiler and the vacuum pump keeps the return pipes clear, storing any excess water in the heater or hot well until it is needed.

With a vacuum pump controlled by a vacuum regulator, the regulator can be set for any desired vacuum on the system from 3 in. to 20 in., which insures the pockets in the heating system being kept free from water which causes sluggish circulation. When a low vacuum is carried it does not require much pressure to operate the vacuum pump, but more power is consumed when the vacuum is carried at 20 or more inches. Steam still has a temperature of 187 deg. when flowing into a vacuum of 12 in. and this is far better than hot water for so large a plant. If it is desired to increase the pressure on the system to meet changes in weather conditions, it is only necessary to change the setting of the reducing valves; but if a higher pressure was carried while operating on a gravity return system, it would be wise to change the sheet iron radiators to iron as a matter of safety, installing radiators which will stand a higher pressure. I have no data at hand on the per cent of efficiency of the return trap compared with the feed pump, but the expense of keeping the valves of the trap tight and in perfect order, plus the loss of the steam used in operating the trap is, in my judgment, more than the cost of operating the feed pump where the exhaust steam can be used to heat the feed water and still have some heat left as a byproduct to turn into the heating system, if desired. The amount of fuel required to operate the pumps can be computed from the horsepower required to run the pump and then make calculations from the kind of fuel used per horsepower-hour. The vacuum pump can be attached to the return pipe of any new or old heating system, at almost any pressures used and operated to good advantage, if the leaks on the system are kept tight to exclude air and provision made to use traps or valves on the high pressure return lines; but if the exhaust steam from the pump is used in the heating system, an oil separator must be used between the heater and the heating system or other means provided to separate the cylinder oil carried with the steam into the heating system from the returns, to prevent the oil getting into the boiler.

The boiler capacity at minimum efficiency is around 50 hp. and may be worked up even higher by forced firing.

R. A. CULTRA.

Surface Condenser Operation

IT HAS been called to our attention that the figures given on p. 778 of the Aug. 1 issue, based on heat balance calculations, are likely to be misleading and to arouse unwarranted hopes of performance. We give, therefore, a different method of calculation based on the experience of a large condenser manufacturing company.

Data given were:

Barometer, 29.39 in. mercury at 67 deg.
Steam condensed per hr., 365,000 lb.
Vacuum at condenser, 27.76 in. mercury at 80 deg.
Temp. exhaust steam, 98 deg. F.
Temp. cooling water, inlet, 60 deg. F.
Temp. cooling water, outlet, 71.5 deg. F.
Temp. condensate in hot well, 89 deg. F.
Condenser surface, 50,000 sq. ft.

Heat transfered to the condenser from the steam would be:

$h' = (H—32) — (3412 \div \text{water rate}) — (t_c—32)$

where, H is the total heat in steam at the turbine throttle; "water rate" is the pounds of steam used per kw. hr.; and t_c is the temperature of the condensate in the hot well.

Assuming initial steam pressure of 175 lb. and superheat of 100 deg. the value of H will be 1255. With a water rate of 11.5 lb. per kw. hr., the value of h′ will be:

$h' = (1255—32)—(3412 \div 11.5)—(89—32) = 870$ B.t.u.

This value in practice is usually about 900 B.t.u. The temperature of 89 deg. for condensate is low, probably due to dirty tubes or air leaks.

Cooling water per pound of steam will be:

$h' \div (t_2—t_1) = 870 \div (71.5—60) = 870 \div 11.5 = 75.6$ lb.

For 365,000 lb. of steam per hr., this will give $365{,}000 \times 75.6 = 27{,}594{,}000$ lb. cooling water per hr., or dividing by (8.33×60), about 55,200 gal. per min. This is 20 per cent less than given by the other method of calculation.

Correction of vacuum was properly figured, giving an absolute pressure of 1.65 lb. in the condenser, corresponding to a temperature of 95 deg. F.

To figure the heat transfer A U d, where A is sq. ft. of condenser surface, U the heat transferred per sq. ft. per hr. per degree of mean temperature difference between steam and cooling water, and d that mean temperature difference, we have:

$$d = (t_2—t_1) \div \log_e \frac{t_c—t_1}{t_c—t_2}$$

$$= (715\text{-}60) \div \log_e \frac{95—60}{95—71.5}$$

$= 11.5 \div \log_e 1.49 = 11.5 \div 0.399 = 28.85$ deg.

Since A U d = wh′, we have

$U = wh' \div A\,d = (365{,}000 \times 870) \div (50{,}000 \times 28.85) = 220$ B.t.u.

which is lower by 26 per cent than by the other method, and lower than it should be, probably due to dirty tubes.

A value common in practice is 400 B.t.u., although better results can be obtained by keeping the condenser in the best of condition. The values of 700 to 1000 mentioned in the previous discussion are from laboratory results and with steam free of all air.

Lack of Boiler Capacity

IN THE issue of June 1, page 580, "Operator" asks for a criticism of a set of diagrams. I am inclined to think his trouble is more lack of boiler capacity than engine trouble. Unfortunately, he does not say what his

average electrical output is, but I feel sure that if it is anywhere close to full capacity he would need more than two 18-ft. by 72-in. boilers. The horsepower required to run a 250-kw. generator at capacity would be, allowing 85 per cent mechanical efficiency, 250 ÷ 0.746 ÷ 0.85, or 394 hp.

Assuming a water rate of 23.5 lb. per hp.-hr., which is a fair figure for this type of engine, I find that the boiler horsepower required is

$$\text{B.hp.} = 23.5 \div 34.5 \times 394 = 268 \text{ hp.}$$

Practically, you could add 10 per cent to this figure to make it 295 hp., as I imagine you have also the usual auxiliaries, such as feed pump, stoker engine, etc., to add to the total.

A horizontal return tubular boiler, 18 by 6 ft., generally has from 1200 to 1500 sq. ft. of heating surface, depending on size and number of tubes. This, allowing 12 sq. ft. of heating surface to the horsepower, fixes the horsepower of the boiler at 100 to 125. This would give you 250 boiler hp. for the two boilers, allowing the greater value. Your over rating is then (295 — 250) ÷ 250 × 100 = 18 per cent.

REG. A. WOODS.

Steam Loop; Governors

WHAT IS the steam loop and where is it used?

2. What is the difference between an inertia and a centrifugal governor? J. N. G.

ANSWERS

THE "STEAM LOOP" is a system of piping by means of which water of condensation in steam-pipes is automatically returned to the boiler. In its simplest form it consists of three pipes, which are called the riser, the horizontal and the drop-leg. When the steam loop is used for returning to the boiler the water of condensation and entrainment from the steam-pipe through which the steam flows to the cylinder of an engine, the riser is generally attached to a separator; this riser empties at a suitable height into the horizontal, and from there the water of condensation is led into the drop-leg, which is connected to the boiler, into which the water of condensation is fed as soon as the hydrostatic pressure in the drop-leg in connection with the steam-pressure in the pipes is sufficient to overcome the boiler-pressure. The action of the device depends on the following principles: Difference of pressure may be balanced by a water column; vapors or liquids tend to flow to the point of lowest pressure; rate of flow depends on difference of pressure and mass; decrease of static pressure in a steam-pipe or chamber is proportional to rate of condensation; in a steam-current water will be carried or swept along rapidly by friction.—Kent.

2. Both the inertia and the centrifugal governor are made in the form of shaft governors which so adjust the position of the eccentric as to alter the point of cutoff. The centrifugal governor depends for its action wholly on the centrifugal force developed in two or more weights. The inertia governor consists essentially of two weights mounted rigidly on a bar which is so attached to the flywheel of an engine as to alter its position, depending on the change of speed of rotation of the flywheel. Its action depends principally on the inertia of the weights, that is, the resistance of these weights to being moved or stopped. As the engine tends to speed up, the weights lag behind the flywheel and so alter the position of eccentric that the cutoff is shortened. As the engine slacks up, the weight of the inertia bar tends to carry it forward with the effect that the cutoff is lengthened and more steam supplied to the engine.

Power to Compress Air

A TWO-STAGE intercooled air compressor, size 25 by 15 by 18 in., driven by a cross-compound condensing engine at 70 r.p.m., compresses air to 55 lb. gage.

What horsepower would be required to do this work?

What saving in power is effected by using a condenser and on intercooler? READER.

A. The work required to compress air varies with the conditions under which it is accomplished. First there is what is called adiabatic compression in which the air neither receives nor gives up heat during the process and then there is the isothermal compression in which the temperature of the air remains constant during the change. Neither of these processes is obtained in actual practice. The first would mean that the cylinder walls, head and piston of the compressor would have to be perfect non-conductors of heat or that the compression would have to take place with such speed that there would be no time for the transmission of heat. To obtain isothermal or constant temperature compression, it would be necessary to cool the cylinder and run at such a speed that the heat generated due to compression would be dissipated as it is formed. In actual practice it is assumed that the compression is intermediate between adiabatic and isothermal. $PV^n = C$ is the general equation for change of state. For an isothermal change, $n = 1$; for adiabatic, $n = 1.4$, an experimentally determined exponent. For our purpose we can assume $n = 1.3$.

The work done in a two-stage compressor per stroke, assuming perfect intercooling, is given by the equation

$$W_2 + W_1 = n \div (n - 1)\, p_1 V_1 \times [2 - (p_3 \div p_2)^{(n-1) \div n} - (p_2 \div p_1)^{(n-1) \div n}]$$

where W is the work, p_1, p_2 and p_3 are the initial, intermediate, and final pressures, V_1 is the initial volume per stroke.

To obtain best economy,

$$(p_3 \div p_2)^{(n-1) \div n} + (p_2 \div p_1)^{(n-1) \div n}$$

must be a maximum, which it is when $p_2 = \sqrt{p_3 p_1}$.

Substituting, then, this value for p_2 in the work equation and simplifying, we get

$$W_2 + W_1 = n \div (n - 1)\, p_1 V_1 \times [2 - 2\,(p_3 \div p_1)^{(n-1) \div 2n}]$$

Evaluating this equation, we obtain

$$W = 1.3 \div 0.3 \times 144 \times 14.7 \times 0.7854 \times (25)^2 \times 18 \div 1728 \times [2 - 2\,(69.7 \div 14.7)^{(0.3 \div 2.6)}] = -18{,}500 \text{ ft.-lb.}$$

The negative answer indicates simply that work is being done on the air instead of the air doing work in the cylinder.

If the compressor is double acting and is running at 70 r.p.m., the work in foot-pounds per minute would be 18,500 × 2 × 70.0 = 2,590,000 ft.-lb., and the horsepower 2,590,000 ÷ 33,000 = 78.5 hp.

Allowing for 85 per cent mechanical efficiency of the engine and compressor, the engine indicated horsepower would be $78.5 \div 85 = 92.5$.

Without intercooling, the work necessary to compress this air would be

$$W = n \div (n-1)\, p_1 V_1 [1 - (p_3 \div p_1)^{(n-1) \div n}]$$
$$= 1.3 \div 0.3 \times 14.7 \times 144 \times 0.7854 \times (25)^2 \times 18 \div 1728 \times [1 - (69.7 \div 14.7)^{(0.3 \div 1.3)}]$$
$$= -20{,}300 \text{ ft.-lb.}$$

The horsepower required would be

$$20{,}300 \times 2 \times 70 \div 0.85 \div 33{,}000 = 101 \text{ hp.}$$

The saving by intercooling is then

$$101 - 92.5 = 8.5 \text{ hp. or}$$
$$8.5 \div 101 = 8.4 \text{ per cent.}$$

The gross percentage of gain in the horsepower of an engine running condensing as compared with non-condensing operation is $100 \times P_1 \div P$ where P_1 is the reduction in back pressure, pounds per square inch and P is the mean effective pressure running non-condensing. Roughly, 1 lb. mean effective pressure is gained for each 2 in. of vacuum used.

The result of using a vacuum in connection with this engine would not be to increase the power, which is fixed at 92.5 hp., but to increase the horsepower hours per pound of steam used, i.e., to decrease the water rate.

Heat Equivalent

WILL YOU kindly answer the following questions for me?

1. At what temperature is water at its greatest density?

2. If one watt is equal to 44,236 ft.-lb. or 0.0568 B.t.u., how long will a current of one ampere under a pressure of one volt have to flow to produce 0.0568 B.t.u.?

3. What is the heat equivalent of one kilowatt-hour?

4. It is claimed that 20 amp. at 110 v. will heat 1½ gal. of water per minute from 60 to 200 deg. F. Is this so? G. A. P.

ANSWERS

Water is at its greatest density at 39.2 deg. F.

2. A current of 1 ampere at 1 volt is one watt, which is equivalent to 0.05686 B.t.u. per min., therefore this current would have to flow for 1 min. to supply 0.05686 B.t.u. if the conversion were perfect. To supply 1 B.t.u. would require 17.6 min.

3. From the foregoing 1 kw.-hr. is equivalent to $1000 \times 60 \times 0.0568 = 3411$ B.t.u.

4. One gallon of water at 60 deg. F. weighs 8.33 lb. To heat 1½ gal. per min. from 60 to 200 deg. F. or 140 deg., would require $8.33 \times 1\frac{1}{2} \times 140 = 1750$ B.t.u. per min. 1750 B.t.u. per minute is equal to $1750 \times 60 \div 3411 = 30.8$ kw. At 110 v. this would require $30{,}800 \div 110 = 280$ amp. If 20 amp. only are available, the time required would be $280 \div 20 = 16$ min. to accomplish the desired results.

Boiler Horsepower Required

WILL YOU kindly inform me of the necessary steps required to calculate the boiler horsepower required to run a 1000-kw. direct-connected steam turbo-generator? Steam consumed by turbine 17.7 lb. per kw. at 150 lb. gage pressure. Efficiency of generator set 80 per cent. F. W. R.

A. If the generator develops 1000 kw. and the efficiency of the set is 80 per cent, the indicated power of the turbine would have to be $1000 \div 80 = 1250$ kw. If the water rate is 17.7 lb. per kw., $1250 \times 17.7 = 22{,}125$ lb. of steam will be required per hour or the actual evaporation of the boiler will have to be 22,125 lb. per hr. If your feed water is at a temperature of, say, 150 deg. F., the heat supplied per pound of water will be $1195 - 150 + 32 = 1077$ B.t.u. (These figures for the heat of the steam are obtained from a steam table.) The equivalent evaporation, from and at 212 deg. F. would be $1077 \div 970.4 \times 22{,}125 = 24{,}555$ lb. As one horsepower is equivalent to the evaporation of 34.5 lb. of water from and at 212 deg. F., the boiler horsepower required would be $24{,}555 \div 34.5 = 710$ hp.

Belt Speed

CAN YOU give me the rule for computing belt speed?

2. What gain in power is made by increasing the pulley diameter? If, for instance, I am driving a 10-in. pulley from a 72-in. drive wheel, what power would be gained if I substituted a 14-in. pulley for the 10-in. one? J. W. W.

ANSWERS

THERE ARE various empirical formulas for determining the horsepower which a belt can transmit. For a single belt

$$Hp = b \times v \div 800$$

and for a double belt

$$Hp = b \times v \div 500$$

are equations which are frequently used. These can of course be turned around to give the belt speed necessary to transmit a given horsepower with a given width belt. In the first case

$$b = 800 \times hp \div v$$

2. In some cases the power transmitted to a shaft may be increased by increasing the diameter of either or both pulleys, because in this way the arc of contact is increased. An increase in the driven pulley diameter will increase its arc of contact but at the same time it will decrease that of the driving pulley. It must also be remembered that a larger diameter driven pulley will mean a slower driven shaft speed and an increased torque.

An increase in the size of the driving pulley will mean that the rim speed and consequently the belt speed will be increased and therefore a narrower belt may be used to transmit the same power.

Proposed Hydroelectric Plant in Wyoming

DURING a recent discussion between the reclamation service of the federal government and the state of Wyoming pertaining to the use of water from the North Platte River, the matter of erecting a 100,000-hp. hydroelectric station from two dams on the North Platte, one in Seminole Canon above Casper, and the other near Guernsey were discussed and approved by the reclamation service. J. B. DILLON.

POWER PLANT ENGINEERING

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Problems in Human Engineering

Of all the problems with which the engineer must deal he finds the human element the most perplexing, most uncertain and he never knows when his solution is 100 per cent correct. The problem is only started when a man is employed at a salary which he accepts as satisfactory and he has gone through the probation period and has proved to be a capable and desirable employe so far as the duties assigned to him are concerned. The big problem is to surround that man with an environment which will keep him happy at the employment to which he may be assigned. No two men have ambitions exactly alike and the ambitions of every man change as his experiences and accomplishments broaden. Age, also, has its influence on the spirit of every man. Who is it that can write a universal prescription for happiness or contentment?

In attempting a solution to at least part of these age old problems of human engineering, modern industry has developed organizations within companies known as mutual benefit associations and although there have been failures, we have today in this country a number of such associations that have proved eminently successful in giving to their members contentment and advantages which reflect definitely in their work. How this is accomplished by one association is told by Mr. Anderson on other pages of this issue where we find six principles laid down as necessary for the foundation of a successful mutual benefit association, but back of it all is the Golden Rule.

That such associations have good cause for existing and thriving, we have only to compare some of the statistics given by Mr. Anderson in regard to time lost by sickness with figures contained in the recent report of the committee on elimination of waste in industry appointed by the Federated American Engineering Societies.

We note in this report that in the state of Wisconsin the costs to employers for medical and surgical aid and hospitals' bills, and the overhead expenses of insurance, equaled 86 per cent of the actual compensation paid to workmen. These figures do not include expenses incurred by workmen for such services.

In 1909 the average loss of time per person per year on account of illness was 13 days, estimated today as 8 or 9 days, yet Mr. Anderson reports that the average number of days lost per case of sickness was only 11.3, while the average loss, we calculate, for the entire membership on account of both sickness and accident amounts only to 5.8 days. This means at least more than 25 per cent reduction in lost time, as compared with the general public, due to health in an industry recognized as dangerous.

Not alone in the matter of health is such an association of benefit to its members and the industry, but it has proved, where successfully managed, a channel through which many other problems are continually being solved. For example, in this report on the elimination of waste a number of recommendations are made from which we select the following as questions which should rightfully come before a mutual association for discussion before ways and means for their accomplishment are put into operation: Maintenance of plant and equipment, uniform cost accounting, methods of wage

payment, performance standardization, maintaining personnel, improving health, prevention of accidents, increasing production, standardization of work, rules regarding restrictions, and improving industrial relations.

It would be manifestly impracticable to organize mutual benefit associations along the comprehensive lines outlined by Mr. Anderson where the employes are small in number, but the principles he advocates can well be made a code in the formulation of policies dealing with the relations between the owners and employes.

The Watchdogs of the Power Plant

Instruments are the watchdogs of the power plant. They indicate when and where wasteful methods or conditions are robbing you of valuable commodities just as surely as your barking dog warns you of a burglar attempting to break into your house.

Would you, respected reader, calmly sit by and allow a burglar to rob your house, ignoring all the while the efforts of your watchdog to warn you? The chances are one thousand to nothing that you would not. Is there any reason then for ignoring the warnings of power plant instruments in regard to wasteful leaks and methods? No! Not a single one!

Yet there are plants, not many fortunately, which have good instrument installations, but where no attempt is made to make use of them. It has been repeatedly said, in these columns and elsewhere, that no instrument installation is worth anything more than the scrap or secondhand value of the instruments themselves unless their records are intelligently interpreted and consistently applied in daily operation. The most perfect instrument equipment and the most complete knowledge of their operation will not result in an increase in economy unless they are correctly used.

It is not sufficient merely to install instruments throughout the power plant and expect the plant personnel to use them. An adequate system of records goes hand in hand with a good installation of instruments. The readings of many instruments tell the operator nothing unless such readings are carefully recorded and compared over extended periods of time. Every variable must be permanently recorded in such a manner that its cause or effect upon other variables may be quickly ascertained and so that the chief engineer may determine the effect of one operating condition upon the other.

Records kept in a haphazard manner are worse than useless, since they lead the man in charge to believe that he "knows what's going on" whereas, if he had no records at all, he might suspect the existence of unfavorable conditions and be more wary as a consequence.

An accurate record system is the means by which information furnished by power plant instruments is rendered available for the use of the engineer controlling operation.

Now, the question may be asked, what constitutes a good record system? While it is evident that there are no hard and fast rules for planning a record system for any particular plant, there are nevertheless certain principles which should be incorporated in record systems applying to all plants. In the pages of this issue Claude C. Brown describes a record system which is in actual use in a large Western plant. The forms which Mr. Brown submits are probably not directly applicable to plants outside of his own, but the fundamental principles on which these forms are based may be easily determined and a corresponding set of forms made which will apply to the plant in which the reader is interested.

As to instruments, the reader is referred to the article describing the plant of the Continental Motors Corporation as an excellent example of what a modern plant should contain in the line of indicating, integrating and recording apparatus.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

Clean Business*

By Dr. Frank Crane

BETTER than big business is clean business.

To an honest man the most satisfactory reflection is not that his dollars are many but that they are all clean.

What constitutes clean business? A clean profit is one that has also made a profit for the other fellow. This is the most fundamental moral axiom in business. Any gain that arises from another's loss is dirty. Any business whose prosperity depends upon damage to any other business is a menace to the general welfare.

That is why gambling, direct or indirect, is criminal, why lotteries are prohibited by law, and why even gambling slot-machine devices are not tolerated in civilized countries.

When a farmer sells a housekeeper a barrel of apples, when a milkman sells her a quart of milk, or the butcher a pound of steak, or the dry-goods man a yard of muslin, the housekeeper is benefited quite as much as those who get her money.

That is the type of honest, clean business, the kind that helps everybody and hurts nobody.

Of course as business becomes more complicated it grows more difficult to tell so clearly whether both sides are equally prospered. No principle is automatic. It requires sense, judgment and conscience to keep clean; but it can be done, nevertheless, if one is determined to maintain his self respect.

A man that makes a habit, every deal he goes into, of asking himself: "What is there in it for the other fellow?" and who refuses to enter into any transaction where his own gain will mean disaster to someone else, cannot go far wrong.

A factory where many workmen are given employment, paid living wages, and where health and life are conserved, is doing more real good in the world than ten charitable institutions.

* Copyright, 1921, by Dr. Frank Crane.

New England N. A. S. E. Meets at Providence, R. I.

ANNUAL convention of the New England Division of the N. A. S. E. was held this year in Providence, R. I. As has been the custom for some years, the convention was held in conjunction with the convention and mechanical exhibition of the New England Association of Commercial Engineers. The display of power plant accessories was not as extensive as was that of some previous conventions, but in quality, attractiveness and valuable suggestions to progressive manufacturers, master mechanics and engineers, the high standards of the past were fully maintained.

The convention and exhibition of this year took place on July 14 and 15 in Infantry Hall. The booths of the exhibitors occupied the large floor on the second story and were of neat appearance in a color scheme of green and white. Many of the exhibitors ornamented their booths with flowers and potted plants but there was no general decoration of the hall.

The opening exercises of the convention took place in the exhibition hall at 8 p. m. on Wednesday and consisted of an address of welcome by Lieut.-Governor Harold J. Gross, and interesting speeches by E. F. Salisbury, president of the Providence Chamber of Commerce; Dudley G. Kimball, president of the New England Association; Major W. H. Myrick, H. Nelson, secretary of the Chamber of Commerce, and officers of the association.

The first formal session of the delegates to the convention was held in the upper hall of the building on Thursday. The proceedings opened with an address by Mayor Joseph H. Gainer, of Providence, who warmly welcomed the engineers on behalf of the city and noted with strong commendation the important contribution of the engineers to the industrial growth and prosperity of Providence. Dudley G. Kimball, president of the New England Association; E. H. Kearney, past national president N. A. S. E.; T. N. Kelsey, past president N. A. S. E.; M. H. Bronsdon, city engineer, and J. C. Wayner of the Chamber of Commerce, made brief and appropriate addresses.

In the course of the addresses the interesting facts were brought out that the first steamboat in this country was built in Providence, that Providence was the birthplace of the Corliss engine, and that the initial meeting from which the National Association of Stationary Engineers developed was held in the boiler room of the old court house on College Hill, Providence. It was shown by numerous citations that Rhode Island, though small in territory and population, loomed large in the history of steam-engineering in America.

The business meeting of the N. A. S. E. delegates was held Friday morning and after the transaction of routine business and listening to an address by Past National President John J. Callahan, of Jersey City, the convention adjourned until 2 o'clock. At the afternoon session it was voted to accept the invitation to hold the 1922 convention of the association in Springfield. Also that the association be represented by a booth at the annual convention of the cotton manufacturers which is to be held in Mechanics Hall, Boston, Mass. The annual report showed the New England membership to be 1992 and plans were adopted to make a drive for increased membership during the coming year. The following officers were elected for the ensuing year: President, Dudley G. Kimball, Boston, Mass.; vice-president, Thomas H. Henderson, Hyde Park, Mass.; secretary, Francis L. Tyler, Taunton, Mass.; treasurer, Walter H. Damon, Springfield, Mass.; conductor, John H. Graham, Fall River, Mass.; doorkeeper, Thos. Livingston, Meriden, Conn. The officers were installed by Past National President William Reynolds of Hoboken, N. J., who also addressed the convention urging active work for securing increase in the membership of the organization.

NEW ENGLAND ENGINEERS AT CONVENTION

The New England Association of Commercial Engineers held its annual business meeting Friday afternoon and elected the following officers: President, Stanford C. Smith; vice-president, Henry H. Lynch, and treasurer, James W. H. Myrick. Directors elected for three years were: Harry H. Atkinson, Claude D. Allen and John A. Morehouse.

On Friday evening a buffet lunch was served and a "smoker" held in the upper hall, where delegates and exhibitors were entertained until a late hour. At the close of the smoker a pair of gold cuff buttons and a gold-mounted fountain pen were presented to President Dudley G. Kimball as a token of esteem by the delegates.

THE BIG a.c. had gone out of "step" and the boss was as mad as a wet hen. The plain truth was the boys were more interested in the brass band, outside, playing some popular airs, than they were in their work.

After the "old man" had his say, Scipio said: "Say, Rastus, you'se any idee what put 'er outa step?"

"Course I has. Who can keep step wif Jazz?"

National Convention N. A. S. E.

THIS year the convention will be held at Evansville, Ind., Sept. 12 to 16. Monday will be devoted to reception of delegates and visitors, registration, and the opening of the mechanical exhibit. Sessions of the Association will open at 10 a. m. Tuesday with addresses of welcome; at 2 p. m., a business and technical session will be held, with paper on Modern Passenger Elevators by W. E. Cory, of Chicago. A theater party will occupy the evening.

Wednesday morning at 9:30 will be a business session followed at 10:30 by a paper, "What the Bureau of Mines Has Done for the Power Plant Engineer," by Henry Kreisinger, the ladies meantime taking an auto trip about the city. Field sports will take up the afternoon, and an entertainment by the National Exhibitors Association will be given in the evening.

Thursday mornings session will take up further business and a paper on "Poppet Valve and Uniflow Engines," by George A. Cooper of the Hoover, Owens Rentschler Co., of Hamilton, Ohio. In the afternoon, a business session will be followed by a steamboat ride on the Ohio River, with luncheon and dancing. The National Exhibitors Association will again entertain in the evening at Memorial Coliseum.

Friday will be devoted to concluding business sessions, with installation of the new national officers, concert and ball at the McCurdy Hotel.

Round trip rate of one and one half fare has been granted for practically all territory except the Pacific Coast states (not yet heard from), and the New England states. The latter will sell tickets on a basis of regular fares to New England boundaries and the reduced rate from there to Evansville. Reduced tickets will be sold for delegates, exhibitors and their families only on presentation of delegates' indentification certificates signed by headquarters of the N. A. S. E. Such certificates can be obtained from F. W. Raven, Sec'y, 417 S. Dearborn St., Chicago. A special train will leave Chicago, Monday, Sept. 12, at 9:30 a. m., over the C. & E. I. R. R. from Polk St. Station.

Ash Handling

By Guy S. Hamilton

COAL is valuable. It costs money and carries potential energy which can produce wealth. Ashes are refuse, without value and their handling results in no increased wealth. Nevertheless, uneconomical ash handling is a waste, which should be overcome.

An instance, the Ebling Brewery of New York, having six boilers, total 2700 hp. with Murphy furnaces, was burning 45 tons of coal a day, running 24 hr. and resulting in 15 to 20 per cent of ashes which were handled in a wheelbarrow by one man, who spent his entire time keeping the ash pits clean.

After investigation, the chief engineer installed a steam jet conveyor system with pipe 8 in. in diam. running in front of the stoker pits, and an ash intake from each pit. When the fireman cleans a fire, he opens the steam valve to the conveyor, and rakes or shovels the ashes into the intake. The conveyor carries them to any desired point.

This equipment cost $3000 and the chief engineer estimates that in two years he has made a saving in wages of $11,232.

In Taber, Canada, at a big mine plant, a conveyor allowed of relieving two men and a team from ash-handling, for other work, reducing the cost from $16.46 a day to $4.08, saving $12.38 daily. It pays to watch all parts and operations in a plant for the opportunity to effect savings.

Additiona Generating Capacity Installed at Cohoes

THE COHOES Power and Light Corporation, Cohoes, N. Y., one of the oldest organizations for the development of hydraulic power in the United States, is making substantial additions to its power plant on the Mohawk River, and has recently received a new General Electric 9000-kv.a. vertical waterwheel generator which will make a total of four installed.

The present plant, which is a consolidation of several small installations, was built and put into operation with three generators in 1915, rated 9000 kv.a.,

INTERIOR VIEW OF COHOES POWER AND LIGHT STATION

185 r.p.m., 12,000 v., 40 cycles, giving the plant an initial capacity of 30,000 hp. The ultimate capacity is expected to be 50,000 hp., of which 40,000 hp. is provided for by the addition of the new machine.

The new generator is of the three-phase revolving field type. The armature winding consists of form wound barrel type coils, all of which are interchangeable. Windings are Y connected, and temperature coils are installed in them.

The rotor spider is made up of one solid steel casting with pole pieces dovetailed into the main spider, the whole rotor being designed to withstand 80 per cent over speed with an ample factor of safety. The flywheel effect of the rotor is 1,700,000 lb. ft. The entire weight of the turbine runner, hydraulic thrust and generator rotor is carried on a spring thrust bearing.

The generator is excited by a 250-kw. direct connected exciter, which is capable of furnishing excitation for three 9000-kv.a. machines, if necessary.

Large Generator Shipment

THE ACCOMPANYING photograph shows the largest single shipment ever made from the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Co. This is the stator of a 35,000-kw. turbine-generator for the Gold St. Station of the Brooklyn Edison Co. This generator when loaded on a special 95-ton car weighed 201,000 lb. and because of its dimensions, 16 ft., 6 in. in height and 8 ft., 4 in. in width, had to be taken over a special route in order to avoid railroad tunnels.

When it arrived at the pier in New York the lighters which were to carry it across the sound to the Brooklyn Edison Co. had to be reinforced. The workmen, ready to install it in its housing, also found added difficulty in that, having no crane facilities, they had to jack up this huge weight a distance of 20 ft.

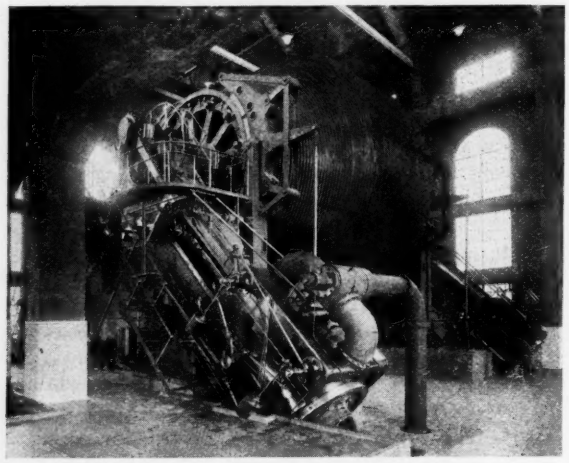
35,000-KW. GENERATOR LOADED ON SPECIAL 95-TON CAR

In spite of the difficulties attendant upon shipping, the special car, with its weighty load, went from East Pittsburgh to New York in seven days.

Mammoth Mine Hoist

A MAMMOTH steam-driven hoist whose 10,000 ft. of rope alone weighs 41,500 lb. has just been installed and placed in operation at a copper mine in the upper peninsula of Michigan. It is declared to be the largest hoist of its type in the world. The hoisting engine is duplex, cross-compound, condensing, and operates in balance. It has been designed for hoisting a load of 10 tons of rock at a maximum rope speed of 3200 ft. per min. The drum is of the cylindro-conical type. Its greatest diameter is 30 ft. and its smallest 16 ft. Two main bearings support it; these are 54 in. long, by 28 in. in diameter. They are placed upon triangular castings that in turn rest on concrete foundations, and which also support four engine frames and cylinders. The rope that can be wound on the drum attains a vertical depth of 6600 ft. in the inclined shaft.

The drum itself weighs 516,000 lb., and is constructed of 48 sections which are securely bolted together and are provided with inner trussing that prevents any deflection. Post brakes 16 ft. in diameter are attached to each end of the drum. Each pair of brake shoes is operated by an oil cylinder; and is controlled by special poppet valves, one of which controls the lift and the other the drop of the piston. The valves are so arranged that they can both be operated simultaneously.



30-FT. DIAMETER MINE HOIST

By means of a floating lever gear, the operator has control of all of the mechanism. As the skip nears the landing, the throttle can be automatically closed by means of an improved safety stop. If overwinding occurs, the brakes are applied automatically. The control is also arranged in such a manner as to keep the hoist from starting in the wrong direction. A speed governor that controls the cutoff cams of the valve gear prevents overspeeding.

The total weight of the hoist, which is the product of the Nordberg Mfg. Co., and condensing equipment is 1,765,000 lb. From the foundation to the top of the drum is 60 ft. The skip weighs 10,000 lb. and is 4 min., 8 sec. in making the trip of 10,000 ft.

Dings Magnetic Separator

MOST PLANTS, using any considerable amount of coal, purchase the unsized product, which, for best operating conditions must be properly sized before firing. This operation is performed by some kind of crusher. As there is a good deal of foreign material, in the form of car springs, bolts and nuts, pick points, etc., that comes along with the coal, and which the crusher is not designed to handle, it must be removed or the crusher will suffer. Especially is this separation necessary in the preparation of pulverized coal. Any metallic object that gets into the pulverizer is liable and likely to cause a spark which may result in an explosion.

The Dings magnetic separator is designed to effect this separation. The apparatus consists simply of an energized magnetic pulley which is used as the driving pulley at the discharge end of the belt conveyor which carries coal to the crusher. This pulley is built up of alternate laminations of north and south poles of magnets which are excited by a coil carrying a d.c. current

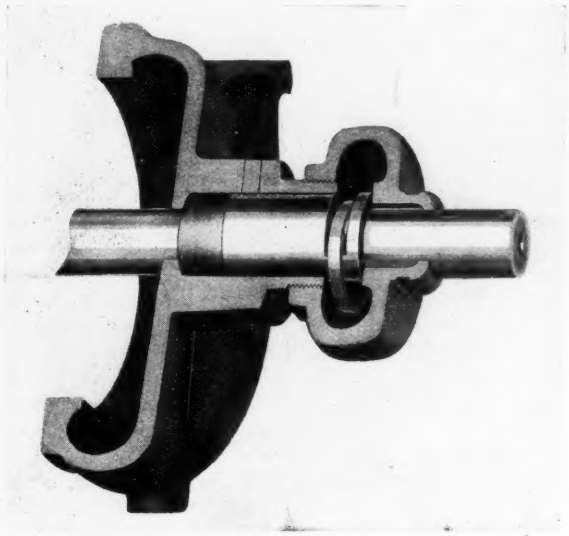
brought into the pulley through a pair of slip rings on an extension of the pulley shaft. All non-magnetic material passing over the drum on the belt is discharged to a hopper in the usual manner. Magnetic pieces are held against the belt until it begins to leave the drum when iron scraps pass outside of the influence of the magnet, when they drop into a receiver.

The savings effected with such a separator are not due primarily to the savings in repairs on the crusher but rather to the time saved while these repairs would have to be made.

Packing Gland and Bearing

CENTRIFUGAL and other rotating types of pumps in which will be incorporated a unique design of packing gland with ring oiling principle have recently been placed on the market by the Arrow Pump Co. It is claimed that this construction eliminates trouble with leaky glands and scored shafts.

The accompanying cut-away view shows in detail an example of the construction. This feature is applicable to any of the many devices requiring the packing of a rotating shaft.

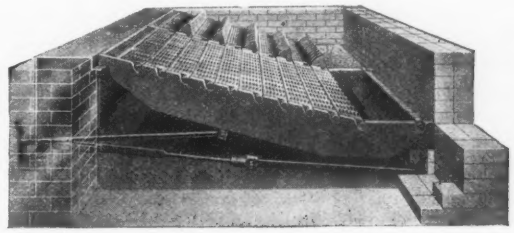


CUT-AWAY VIEW OF ARROW PACKING GLAND AND RING OILING SYSTEM

The packing gland in this construction is so arranged in combination with an adjustment nut and oil reservoir as to permit of the use of the ring oiling principle of lubrication. In this manner a constant and positive flow of oil is supplied to the gland, making it practical to use it also as a bearing. In this way, the shaft is supported at a point close to the load, which eliminates a long overhang. In this construction deflection of shaft is prevented and the seal of the packing is therefore undisturbed. It is this constant disturbance of the packing by deflections in improperly supported shafts that cause leaking glands. When deflections and vibration of shaft are prevented as in this construction metallic packing affords all the resiliency necessary to seal completely without scoring the shaft. Since this method of lubrication keeps a film of oil constantly between the packing and rotating shaft, as well as in the bearing, the packing is not subjected to the wear it would otherwise have, and for this reason, coupled with its not being disturbed, will hold its seal for long periods without adjustments.

Vogt Hand Stoker

THIS stoker, shown in the illustration, has an inclined surface and shaking sections which work the fuel down and back as it is consumed. The coal is fired at the front of the furnace and coked before being passed on over the grate, so that the volatile gases pass over the incandescent coke bed below. Alternate sections of the grate are moved by a hand-operated bar from the front, thus breaking up clinkers and passing the fuel on, ashes being dumped from the drop ash grate at the bottom.



VOGT BROS. HAND STOKER

Each section is made up of a carrier bar, a lever trunnion grate at one end and a number of sections each 3 in. wide and replaceable independently. A plain trunnion grate at the other end furnishes bearing on the other bearing bar. The dead plate at the front end is dovetailed to the side bearing bars, preventing spreading.

News Notes

THE FEDERATED AMERICAN ENGINEERING SOCIETIES, representing a combined membership of about 50,000, has established at 29 West 39th Street, New York, an employment bureau for engineers of every variety of training and experience. Applicants must be members and submit a complete educational and professional record which is carefully classified, so that as the special requirements of any positions are received, the records of men of suitable qualifications are submitted for consideration. The relatively large number of men with whom the bureau is in touch, the comprehensive classification of records, and the fact that the services of the bureau are free to employer and member alike, renders possible the selection of the right man for the service required. The bureau will welcome inquiries from those seeking to build up or expand their engineering organizations.

SECRETARY OF COMMERCE HOOVER has announced the appointment of Walter H. Rastall, of Dayton, Ohio, to take charge of the Department's newly created heavy machinery industrial division. This is one of the new divisions provided for by Congress recently under the Export Industries Act. Mr. Rastall will study especially the problem connected with the marketing of American heavy machinery throughout the world. Departmental

officials believe that the potential market for American heavy machinery is most promising and the hope is expressed that the work of this new division may be instrumental in the sale of much American equipment of this character in industrializing the less developed countries of the world. Mr. Rastall will keep in close touch with the centers of machinery production in this country and by personal contact endeavor to afford that industry and trade maximum service from an informational and marketing standpoint.

U. S. Civil Service Commission announces an examination (receipt of applications to close Aug. 30) for plant engineer, to fill a vacancy at Picatinny Arsenal, Dover, N. J., at $3000 a year, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries, duties to consist of the designing and executing of construction work, maintenance of plant equipment at the arsenal; executive charge of electrical, mechanical, civil, and architectural engineering for the plant. Competitors will be rated on physical ability, education, training, experience, and fitness, and must not have reached their seventieth birthday on the date of the examination. Should the appointing officer so request, certification will be made of eligibles who are within reasonable age limits. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

The Senate passed a resolution, July 27, authorizing the President to invite foreign nations to participate in an exposition at Portland, Ore., in 1925, to celebrate hydro-electric developments.

Albert E. Fisk has recently opened offices at 807 Stock Exchange Building, 30 N. LaSalle Street, Chicago, Ill., and is prepared to do a general business as consulting and contracting engineer.

The Cochrane Steam Specialty Co. of Massachusetts, has been organized to represent in New England a number of well-known manufacturers of power plant equipment, including the H. S. B. W.-Cochrane Corporation, the Steam Motors Company, Inc., and the D. Connelly Boiler Company. The office, which is in charge of Elliott Greene, who has long been connected with the several lines mentioned, is located at 1045 Oliver Building, Boston, Mass.

M. J. Dougherty Co., Philadelphia, Pa., has completed the installation of piping for the waste heat and power plant of Lehigh Portland Cement Co., Oglesby, Ill.; also a similar installation for the Edison Portland Cement Co., New Village, N. J., which included cast-iron water mains and spray pond piping.

Edward E. McKeighan has resigned his position as sales manager, heating sales division, The Fulton Co., Knoxville, Tenn., and will return to his former home, Kansas City, Mo., the last of August, to enter business as a manufacturer's agent, selling heating and power specialties.

The Atlas Valve Co. announces that its New York office has been moved to 242 Lafayette St., New York City. E. E. Jones, district manager, has full charge.

An order for electrical equipment amounting to $1,200,000 has been received by the Westinghouse Electric International Co. from the Midi Railway of France. The order includes transformers, synchronous condensers, lightning arresters and other substation equipment. The Midi Railway operates an extensive system starting from Bordeaux, running through Toulouse to Cette, with many branches. The section on which the Westinghouse equipment will be used extends from Pau to Toulouse in the Pyrenees Mountains near the Spanish border. The line passes through Tarbes and St. Gaudens, and has a total length of over 100 mi.

The M. H. Detrick Co. announces the appointment of H. W. Thompson, 503 Mining Exchange Bldg., Denver, Colo., as sales representative in that territory.

Catalog Notes

THE LINK BELT CO., of Chicago, has just published a new book, No. 215, on belt conveyors describing the Uniroll and Multiroll recommended by the company. The book gives correct methods of figuring belt conveyors and their details, price lists enabling the user to determine the cost of a complete conveyor or any portion of it, suggestions for the right types of conveyors for handling various materials, and illustrations of typical installations. A copy can be had by anyone interested who wants it for his book shelf, by addressing the Link Belt Co., Chicago, Ill.

The Ridgway Dynamo and Engine Co. has recently issued its catalog No. 29, on Unaflow Engines. These engines are built under the Stumpf patents which combine the Unaflow principle with steam jacketed heads and double beat poppet valves. The machining of the cylinder bore is done with great care to compensate for changes in clearance due to the temperature gradient existing in the cylinder. The bulletin describes the engine in detail, part by part, and serves to give a clear idea of the construction.

Form 9207, superseding 9107, is a condensed catalog of Ingersoll-Rand products, subdivided into various classifications for easy reference. Section headings are as follows: Compressors, Vacuum Pumps, Condensers, Oil and Steam Engines, Cameron Pumps, Air Lift Pumps, Rock Drills, Drill Sharpeners, Pneumatic Tools, Tie Tampers, Miscellaneous, Engineering Data.

Vogt Brothers Mfg. Co. has recently issued a new catalog illustrating and describing its hand operated inclined stoker. Directions are also given for starting the fire and the correct procedure to be followed to maintain constant furnace conditions.

Motorize Your Work is the subject of a folder on motors, which the Westinghouse Electric & Manufacturing Co. is distributing. This folder illustrates the Westinghouse Type CA, CD, CAH, ARS and AR motors, and illustrates their particular uses.

A circular relating to the S. & W. oil filter was lately received from Seehausen, Wehrs & Co., 179 N. Franklin St., Chicago.